THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
"Very Influentially Supported"	149
Multiphase Currents	150
"Save us from our Friends"	151
The Lighting of Claybury Lunatic Asylum	151
Underground Conduits in Foreign Towns	154
The "Elastic Medium" Method of Treating Electrostatic Theorems	155
Trial of the Chemical Theory on Lead Accumulators	156
On the Difference of Potential at the Contact of Mutually Reacting Liquids	157
Electric Railway Motor Tests.—Electric Lighting in Islington	158
The Canadian Electrical Association	159
A Contribution to the Chapter on Accumulators: Guarantee ...	160
The First Electrical Furnace for the Fusion of Metals (*illus.*) ...	161
The *Scientific American* Dynamo (*illustrated*)	162
The Electric Lighting of Brussels: The Authorities' Report ...	164
Notes	165
The British Association	170
Legal:—Edison Phonograph Co. *v.* Lynd.—Business Notices, &c.	170
City Notes, &c.:—The Great Northern Telegraph Company ...	171
Crompton & Co.—Direct United States Telegraph Company	172
Anglo-American Telegraph Company	173
Traffic Receipts	173
Share List of Electrical Companies	174
On a Permanent Magnetic Field (*illustrated*)	175
On a New Form of Air Leyden (*illustrated*)	176
Final Hearing on Edison's "Feeder and Main" Patent for Electrical Distribution.—II.	177
New Patents	179
Abstracts of Published Specifications	180
Reviews:—Induction Coils.—Telephones	180
Journal of the Institution of Electrical Engineers—No. 99	180
Notes on the Construction of Cranes and Lifting-Machinery	180
Correspondence:—Concentric Wiring	180

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"VERY INFLUENTIALLY SUPPORTED."

AT the last meeting of the British Association—not yet a year ago—a paper was read in which it was attempted to be proved that there was only one way of telephoning a great city satisfactorily and cheaply. Immediately afterwards a practical turn was given to the paper by a correspondence in the *Times*, serving to show not only the advantages of the "new" system, but also the very serious defects of the old. These defects were said to be so numerous, and so serious, that it would be perfectly useless to attempt to remedy them. The old order could not change for the better. The new order must come in, and when it came in it would be on so substantial and firm a foundation that all the old order could do would be to decay and vanish.

Shortly after this an article was published in the *New Review* by an author of influence, whose knowledge and experience in regard to telephones must have been considerable, since he exposed the defects of the past, and laid down the lines for the future in very definite terms. The article took up the same parable as the paper and the correspondence, carrying it a little further.

About the same period it became apparent that there was considerable dissatisfaction on the part of telephone subscribers, the dissatisfaction finding expression more particularly on two points: the subscription was too good, and the service too bad. Subscribers were so down-trodden that it was necessary to take refuge in the prevailing fashion by forming an association for mutual protection, and electing a committee.

The commercial community were consulted in the matter, and in public meeting assembled at the Chamber of Commerce, voted for the encouragement of a competitive system.

The attention of the Government having been called to the telephone question, partly by a diminishing telegraph revenue, as well as by articles in the Press and otherwise, it was decided to introduce a Government measure, placing the telephone business upon a new footing. The aims of the Government were firstly, to take care of the revenue, and secondly, to aid the development of the telephone, amongst other things by encouraging competition. The Government proposals when submitted were in some respects like those set forth in the *New Review* article, the wonder being whether the Government had sought their measures in the *New Review* or whether the author of the article had intuitively arrived at the same ideas as were entertained by the Government. However that may be, the measures were proceeded with, and one of the last Acts of the session was the passing of the Telegraphs Bill, by which the Government proposals were carried into effect.

All these events have been recorded in our columns, and our comments from time to time have represented them as

nearly as possible in their real light. But the public, the telephone subscribers, and the Government were led to believe that "a new organisation very influentially supported" would enter into competition with an older organisation, and conduce to the public benefit thereby.

Last week the new organisation was announced, and we hope that the public, the telephone subscribers, and the Government are satisfied with the result which they have combined to produce. The new organisation and the old organisation have joined hands and issued a prospectus of a very composite character.

Run as an independent company the position of half its directors is a most difficult one, and it may reasonably be assumed that the present stage of the company's existence is not its last. The difficulties of its position will probably be found to be capable of being simplified by a more complete amalgamation.

Regarded from a practical point of view, we are not sure that the arrangement is altogether a bad one. Less money will be wasted than would have been the case if a competition had been entered into, and the interest of the National Company in the share capital of the New Company is only an attempt to arrive at a solution of what we described as the almost impossible task of finding an equitable arrangement for the interchange of subscriber's calls between two companies. We say advisedly it is an attempt. It does not strike us as by any means an equitable arrangement that the National Company should throw its subscribers open to the New Company in exchange for the privilege of subscribing one-third of its capital, supposing that the New Company is to be free to start an effective competition. The position is only understandable on the supposition that it is a means of preventing a possible competition in a manner satisfactory to the would-be competitors, and of providing additional capital for the development of the business generally.

About two years ago a telephone company was organised in Manchester on co-operative principles, which are apparently not suited to telephones, since the company was in the market at the beginning of this year. It was bought by the Pioneer Telephone Company through the Electric and General Investment Company for an amount not stated. The Pioneer Company is now acquired by the New Telephone Company for £90,000. It may be assumed that profits have been made in process of transfer from company to company.

The profit made by the Pioneer Company is the value which we said would be placed by the Government on the unworked all-England license, when they intimated their intention to grant no more.

The New Telephone Company have agitated and have purchased a property started by others. The result of their agitation, and the policy of the Government in falling in with it, has enabled them to make a profit on the strength of the possession of a license for which they paid nothing.

So much public opinion as has been created in the matter, has arisen almost entirely through an implicit reliance upon the statements of interested advocates. The New Telephone Company, with no record of work done, has been granted before a Parliamentary committee an equal place with an organisation which has done practically all the work. Ministers of the Government have talked of "the companies" as if they were all active organisations. Undoubtedly, so far as any blame for the present state of things can be localised, the Government must bear the chief share.

In criticising the Government measures, it will be remembered that we said there was considerable risk that they might bring about the conditions they were intended to avoid. It is open to everyone now to see how accurate was our criticism.

Had the Government formulated a scheme which was sound in principle, it would probably have done no harm to existing organisations, and would have benefited the public. It was a very difficult question, and ought to have received more consideration. It did not, and the result is before us.

Unsatisfactory as that result is from the point of view of what complacent people were led to expect, we are obliged to repeat what we have remarked from time to time during the past year, that the improvement of the telephone service is not necessarily attained by the competition which interested persons have been so strenuously demanding.

It may reasonably be asked how it is that the defects of the measure were not observed by those in a position of less freedom and more responsibility? Is it possible that others than the Association for the Protection of Telephone Subscribers were relying too implicitly on the fact that the New Telephone Company was "very influentially supported?"

The value of such support is not a negligible quantity. That is now evident. When the next telephone competition arises, no doubt the public, the subscribers, and the Government, will cordially hope that it will not be so "very influentially supported."

MULTIPHASE CURRENTS.

AN interesting discussion on this subject has been going on in the American journals of late, M. Dobrowolski maintaining the superiority of the three-phase system for long distance transmission of power, his opponents maintaining that the advantages claimed for the three-phase system over those of a two-phase system have really no existence. The chief advantages claimed for the three-phase system are greater constancy of magnetisation, and greater constancy of magnetic flux from the rotating poles through the revolving armature. The points raised between the parties in the discussion do not seem to be of really much importance. The real difficulties in the way of multiphase transmission of power with rotary current motors as receivers, arise from the effects of self-induction, and the large exciting currents which have to be dealt with. It is a very significant fact that there appears in the *Electrical Review* of New York, at about the same date as the discussion, a paper describing a transmission of power plant over long distance, by alternating currents erected by the Westinghouse Company, the owners of the Multiphase Tesla Motor Patents. In this plant the Tesla motor plays a very subordinate part. It is employed merely as a starter to get up the speed of the large motor to synchronism; this large motor being an ordinary reversed alternator. Evidently the synchronising motor was considered to be better fitted for the transmission of power in this case than that of Tesla.

There is, in fact, no necessity for the Tesla motor even as

a starter for the synchronising motor; a synchronising motor can be started by Mordey's accumulator method, and by several commutator methods, without any trouble whatever.

There are, however, forms of multiphase motors other than the rotary polar motor, and it is to these we must look for any success in transmitting power over long distances by multiphase currents; if these motors can be operated without commutators, so much the better, but if only a low pressure commutator is employed for constant excitement, there can be small objection to that.

Multiphase currents have been discussed mostly from the motive-power point of view in connection with rotary motors, other properties of perhaps more importance than the rotary polar property of multiphase currents have been overlooked; the facilities with which such currents can be generated and transmitted at high pressure and afterwards converted and distributed, either as alternating or continuous currents, are well worthy of attention.

"SAVE US FROM OUR FRIENDS."

THIS is a cry that is too frequently heard in electrical circles. We say "too frequently," because it would never be heard at all if there were no reason for it. And there is. Electricity is the modern Hercules, and, like the hero of mythology, it is attributed with powers and capabilities by many of its too ardent votaries, the statement of which, if uncontradicted, would soon pass into print as fact. Our remarks are designed to reach not merely the *dilettanti*, but the practical engineers. Many of us suffer from being over-sanguine, and we cannot but carry our idiosyncracies into our professional dealings, with the result that our clients experience disappointment when they never should have had their hopes excited, besides furnishing a "handle" for opposite interests.

We dare affirm that there is not one of our readers who will not be found to agree with us in recommending "the profession, *par excellence*," to exhibit greater caution, and to take care that in all cases their motto be *Festina lente*.

In no case does it behove the engineer more to exercise the virtue of prudence than in making statements concerning the efficiency obtainable with the transmission of power. Perhaps the electrical engineer is not more to blame than others in this respect; but it will be admitted that in estimating the efficiency in the electrical transmission of power, it is too often the practice to separate the items involved in the actual transmission from those dealing with the generation and utilisation of the power. This practice becomes misleading, and gives rise to disappointment, although we do not mean to insinuate that there is any intention to mislead, although it may easily arise from over zeal.

Queer terms have crept in. We hear of "commercial" efficiency when all the losses of energy are taken into account, as distinguished from the "electrical" or "mechanical" efficiency, where these items are taken separately. But some engineers have got into the habit of speaking of the "commercial" efficiency of transmission when they mean the ratio of the power given out at the motor to that absorbed by the dynamo.

We agree with Mr. C. Atkinson, who, in a discussion on the present position of the question of transmission of power at the North of England Institute, prefers to speak of the "plant" efficiency by the name of "commercial" efficiency, meaning, thereby, the ratio of the actual work performed to the indicated power of the prime mover. A better way, perhaps, of looking at it would be to go back to the fire-box and take the true "commercial" efficiency as the ratio of the power utilised to the power available in the fire-box. However, in dealing with the subject which was under discussion at the Institute, the efficiency of transmission, that is

$$\text{Ratio of transmission} = \frac{\text{brake horse-power of motor}}{\text{brake horse-power of engine}}$$

should, obviously, be alone considered, and the losses both in the engine and in the machine receiving power should be left out of account. This is clear from a moment's consideration, for it often happens that when plant is erected, say, at a colliery, a large margin of power is provided for future contingencies, and it is not desirable to consider the losses in an engine working at a fraction of its full load, and to mix them with the losses in the transmitting links.

THE LIGHTING OF CLAYBURY LUNATIC ASYLUM.

IT is commonly supposed that one of the main objects of issuing a specification to firms proposing to tender for electrical or other work, is to ensure that all the estimates shall be made out on the same basis, and shall be for the same quantity and quality of material and workmanship; but the figures, which we published last week, of the tenders sent in to the London County Council for the lighting of their Claybury Lunatic Asylum show that in this case this object certainly has not been attained, as the amounts quoted by well-known firms vary between £28,400 and £13,970, a difference that can hardly be accounted for by any possible difference in the prime cost of equal work to various firms, or by any difference in the sums added by them for profit. We are accustomed to seeing great differences in the prices quoted for work where there is no specification, and firms tendering are free to propose whatever seems best to them as regards the number of lamps and the method of arranging them; but in this case we understand that there was a most voluminous specification which left nothing to the discretion of the would be contractor, except the task of correctly interpreting the meaning of its many clauses, and it may therefore be that the large amount of unnecessary detail and the numerous restrictions imposed have confused those tendering, with the result that some firms may have made a large allowance for contingencies foreshadowed in the specification, whilst others may have made none on the idea that the restrictions imposed were so unreasonable that they would never be enforced. The unfortunate part of the business is that results of the kind named above tend greatly to create a want of confidence on the part of the general public, who not unnaturally conclude that electrical engineers must know very little about their own business, when such differences can exist in the sums quoted; and it is therefore to the interest of all contractors to try and come to some

arrangement as to how they shall deal with such cases, as if they could only agree together to make a stand against the imposition of unreasonable restrictions by uniformly increasing their prices, this class of specification would speedily die a natural death, through the fact that purchasers, as a rule, insert these restrictions only because they too often find that some firms are willing to take the risks implied, without charging for them.

Some of the Troubles of Manufacturers of Incandescent Lamps.

WE suppose it will be conceded that every trade has its troubles and every manufacture its difficulties, and that these conditions govern to no small extent the selling price of the commodities; those who vehemently complain of the price they have to pay for their incandescent lamps will do well to bear in mind this platitude. There is perhaps scarcely any manufacture that could be instanced in which there is more loss from what may be termed "spontaneous" breakage. Finished lamps apparently well made and of the best material will for no very obvious reason crack without having been subjected to any shock or blow. Manufacturers of incandescent lamps always expect a reasonable amount of loss from breakage, but when a certain limit is exceeded some special cause is generallly suspected to be operating, such as carelessness in the glass-blowing department, imperfect annealing, &c. Lamp-bulbs may exhibit this spontaneous cracking as a rule in three *loci*:—1. Where the platinum wires are sealed in. 2. Where the "stem" carrying the wires and carbon filaments is joined to the bulb proper. 3. Where the exhausting tube is sealed on at the apex of the bulb. Now in addition to the internal stresses existing in any such glass work, the lamp bulb when finished is subjected externally to the full atmospheric pressure, and in, perhaps, the majority of lamps in use, the bulb is subjected to sudden heat stresses due to the instantaneous turning on of the current. This combination of stresses being considered, it is evident that differences in the glass used for the bulb and "stem," and consequent differences in the values of the coefficients of expansion will become of special importance; although in the case of ordinary glass-work subjected to no particular stress, such differences would be negligible. Glass blowers know by experience that similar grades of glass should be used together, but they are skilful enough to be able to work up grades of glass differing in composition far more than is permissible in incandescent lamps. Dr. Durand Woodman has had his attention called to this matter by an American firm of incandescent lamp makers, and he was able to investigate the character of the glass at a time when the percentage of spontaneous breaking was abnormally high, whilst every care in making up the lamps, in annealing, &c., was unavailing. A number of samples of glass rod and tubes used in making the bulbs were analysed chemically. From the results of this examination Dr. Woodman concluded that the high spontaneous mortality was caused by using different grades of glass in making the lamps. The lesson to be derived from this investigation is obviously that it is desirable to use the same glass in every part of a lamp, or at least glass of practically the same composition. It has been asserted that some glasses of different composition may have similar coefficients of expansion, owing to the constituents compensating each other's effect, but the determination of this character involves problems connected with the coefficiency of expansion, which after all are unnecessary trouble, since it is a simple matter to obtain glass of practically the same composition for all parts of a lamp, or for any other complex glass-work.

Measuring the Resistance of the Human Body.

THERE has been considerable controversy during the past few months concerning the electrical resistance of the human body, especially in relation to electrocution, and in connection with occasional accidents from electric currents, hence it may be worth while to record some experimental results that have recently been obtained by Von Frey. This physicist employed in his investigation the well-known method devised by Kohlrausch for determining the electrical resistance of electrolytes, but with certain modifications. The "metric length" which is a feature in Kohlrausch's apparatus was replaced by a circularly arranged channel, the ends of which were not, however, placed in communication. This channel was filled with a solution of sulphate of zinc. Much larger electrodes, suitably proportioned to the extent of surface of the wet hands of a person were employed by Von Frey, as those used by Kohlrausch were inconveniently small. With this arrangement it was found that the electrical resistance of the human body was much smaller than has been generally supposed, and varied from 300 to 400 ohms. Von Frey discusses his investigation in a paper which is published in the *Beiblätter Ann. Physik u. Chem.*, No. 4, p. 217 (1892) in the course of which he expresses the opinion that the seat of electric polarisation of the body is the outer surface and layers of the skin.

Iron for Dynamos.

THERE is undoubtedly an opening for some metal which shall more or less approach the permeability of wrought iron, and at the same time be capable of being cast. Messrs. Thompson, Knight, and Bacon, have lately been investigating the magnetic properties of various brands of cast-iron, steel, &c., in the Cornell Laboratory. The most important of their results is to show that cast steel has a permeability of fully 90 per cent. of that of ordinary wrought iron, and is quite equal to mitis metal, without the somewhat undesirable mechanical properties of the latter. Should it be possible to get the proper steel castings at a moderate cost, considerable improvement would be possible in dynamos, especially in the way of increased output for the same weight.

Measuring the Rate at which a River Rises.

THAT electricity is the most cosmopolitan of the agencies which have been impressed into the service of man, has long been admitted. Scarcely a REVIEW is published without containing evidence of some new application of the "mysterious something." One might be excused, however, for not suspecting that by means of it the rate at which a river is rising after a fall of rain might be measured. *Nature* (July 14th), contains a letter from Mr. F. J. Smith, of Trinity College, Oxford, in which he details a method he has successfully employed for determining the increasing depth of water in a river at a distance, which is both simple and ingenious. He used a combination of two organ pipes and a telephonic circuit. At the river bank an organ pipe was fixed vertically in an inverted position, so that the water in the river acted as a stopper to the pipe, and the rise or fall of the water determined the note given out when the pipe was blown by a small bellows driven by a miniature water-wheel. A microphone was attached to the upper end of the pipe; this was in circuit with a wire leading to a town station at some distance; here there was an exactly similar pipe which could be lowered into a vessel full of water while it was sounding. By means of the telephone the note given by the pipe at the river was clearly heard at the town station; then the organ pipe at this station was lowered or raised by hand until it gave the same note. The lengths of the pipes under water at the two stations were then equal,

so that the rise in the distant river was accurately determined. The determination can be made in less than a minute by any one who can recognise the agreement of two similar notes. A difference of temperature between the two stations would make a small difference in the observed heights, but this can be allowed for.

Electric Locomotives.

By a chain of apparently faultless syllogisms, our esteemed contemporary, the *Engineer*, recently attempted to disprove the possibility of the electric locomotive for metropolitan and other heavy railway service. We have heard how that famous logician, Whately, by a similar method disproved the existence of Napoleon the Great. But Waterloo showed up the flaw in the logic of the one, and the South London Electric Railway is an equal—though not perhaps equally important—stumbling block to the *à priori* deductions of the other. Our contemporary believes that "the advantage to be gained by using electricity instead of steam consists *wholly* in keeping the tunnels free of the products of combustion." We have met smoke enthusiasts who would not hesitate to eliminate even this solitary advantage, and who hail the disagreeable smoke as a health preserving disinfectant. Surely, however, we may claim for electricity the advantages of using highly economical condensing stationary engines in place of wasteful locomotives; to say nothing of the saving in labour. It would, of course, be necessary to design the plant so that the load factor of each steam engine should be very high; and here the ingenuity of the railway manager, in designing suitable time-tables for the trains, would be brought into play. All the trains must not start at the same time, neither must they be at rest during the same interval; otherwise the load diagram would be irregular and the economy low. But this is not of the nature of an insuperable difficulty; and by no means warrants the assertion of our contemporary, that the opinion of almost all electricians "that it is possible to work ordinary railway traffic with electric locomotives . . . . is mainly based on ignorance." Difficulties are by no means necessarily impossibilities; for the present state of perfection of steam railway engineering has been reached on stepping stones of apparently insuperable difficulty. One difficulty in the way of the electric railway engineer is, admittedly, the starting effort. The effort exerted by a 500 H.P. locomotive when starting a train of the ordinary number of cars is about 14,000 lbs. This would require a force of something like a ton on the armature periphery. To obtain this without running the risk of a burn-out of the armature, or fusing the cut-outs, is a real and terrible difficulty. One solution of this difficulty lies in reducing the acceleration at the moment of starting; another lies in the adoption of a variable yet reliable reduction gear. The starting acceleration of a steam locomotive is about 0·5 to 1·0 foot per second; but, by allowing a lower figure at the instant of starting, a less effort is required. This would imply a slightly longer period of getting up speed—but, this can hardly be considered a serious objection. Variable reduction gear is, perhaps, not a good solution of a problem in which it is best of all to have a gearless motor. Gearing is always wasteful of power, and takes up space; and variable reduction gear is, at present, viciously unreliable. A third solution of the problem is probably the best of all. In high speed locomotives for heavy trains, at least four, and sometimes six, driving wheels are necessary. On the steam road, except in the case of the compound locomotives of the London and North Western Railway, these are coupled by rods. In electric locomotives, two, three, or even more separate motors may be used, each driving a single axle and pair of wheels. Such motors may be placed in parallel when at full speed, and in series when starting. Let us, in conclusion, learn by the experience of the past. The celebrated Dr. Lardner is said to have avowed his determination to eat the first steam vessel that crossed the Atlantic; but though the meal was shortly afterwards ready, it has ever since remained uneaten.

Pure Platinum.

It is safe to say that there exist but very few specimens of absolutely pure platinum. Most of the platinum employed for electrical purposes is contaminated with minute quantities of iridium, ruthenium, rhodium, palladium, iron, copper, silver, lead, osmium, and even gold; but we know from recent metallurgical researches that even traces of foreign metals will very materially modify the physical properties of the metal in which they occur. Now it will be patent to all who have had the merest insight into the manufacture of electrical apparatus, or have come in contact with the mathematics of electricity, that it is eminently desirable that we should have to deal with *pure* platinum, or at least that its electrical properties should be well ascertained. Chemists have devised methods whereby this metal can be freed from its impurities, but they are all complicated, and what is more to the point perhaps, very expensive. Hence it is satisfactory to hear that Finkener has recently published a method that has been a trade secret in Germany for some time, and against which these objections cannot be alleged. A full account is given in the *Berichte*, xxv., pp. 665—686, but the following gives the salient features of the process. It depends upon the recrystallisation of sodium platino-chloride. Commercial "purified platinum" is dissolved in *aqua regia*; to the solution of the chloride, thus formed and freed from oxides of nitrogen, the calculated amount of pure sodium chloride is added, the solution is concentrated to a small bulk and allowed to cool, whilst being continuously stirred. The crystals which separate are freed from the "mother liquor" by suction, washed with a concentrated solution of sodium chloride, and dissolved in a 1 per cent. solution of sodium carbonate. The solution is allowed to cool, when the salt again separates out. It is dried at 120°, reduced in a current of hydrogen at a low temperature, and the "sponge" thus obtained is washed for a long time with water, and finally dried, ignited, and fused. The metal thus obtained is extremely pure, and not even the most delicate tests will reveal any contamination.

Are all Pure Substances Electrolytes.

Kohlrausch asserts that all pure substances are electrolytes, and if the assumption of Ostwald be true, that chemical reactions take place only between the electrolytic ions, it follows that no reactions are possible between pure substances, and only become possible in the presence of some body which is capable of producing the electrolytic dissociation. Inasmuch as the majority of chemical reactions take place in the presence of water of some other solvent, and since the experiments of Dixon on the explosion of mixtures of dried gases, Wanklyn on the action of dry chlorine on metals, Baker on the combustion of dry substances, and Veley on the action of dry sulphuretted hydrogen on calcium oxide, prove that the presence of water is an essential condition for these reactions to take place, it seems an interesting question to determine whether dried hydrochloric acid gas is capable of displacing carbon dioxide from carbonates. This question, originally suggested by Mr. V. H. Veley, has recently been approached by Messrs. R. E. Hughes and F. R. L. Wilson. Their experiments are to be understood as of a distinctly preliminary character. They consisted in examining the action of dry hydrochloric acid gas on Iceland spar and witherite, and the results were such that no definite assertion can be made of an action having taken place. We believe that the investigation is to be repeated and extended to other carbonates, using greater weights of the substances experimented upon, longer times of exposure to the action of the gas, and more elaborate precautions to ensure the absence of moisture. When the results of this research are published, we shall expect them to have an important bearing upon the theories of Kohlrausch and Ostwald, alluded to above. Details of the preliminary experiments are to be found in the *Phil. Mag.* for July.

UNDERGROUND CONDUITS IN FOREIGN TOWNS.

ABOUT a year ago the Acting Secretary of the Department of State, Washington, U.S., addressed a circular letter to the consular officers of the United States, requesting them to prepare a report on the underground conduits used for telephone, telegraph, and electric light and power in their respective districts. These reports were duly forwarded, and have just been issued in a pamphlet, from which the following is abstracted :—

VIENNA.

Very little has been done in Austria as regards electric lighting, whilst the transmission of power by electricity has not yet been put into practice. Vienna possesses about 70 miles of underground telephone wires, laid in trenches along the sidewalks. With the exception of a connection between the War Office and the different barracks, none of the telegraph wires are placed underground. As regards electric lighting, there are three companies established in Vienna. The General Electric (Siemens) Company has about 20 miles of underground electric light cable, which is iron-sheathed, and laid in ditches covered with one brick. The International Electric Company owns 30 miles of lead-covered cable arranged in wooden troughs covered with pitch, whilst the Imperial Continental Gas Association, which only furnishes light to the two theatres, owns only five miles of lead-covered cable laid in trenches.

ANTWERP.

There is only one underground conduit in this city and district. It was built by the State in 1884, and contains 25 telegraph wires. As the line has never given entire satisfaction, an overhead service is projected.

BRUSSELS.

The Belgian telegraph service put down in 1851 the first underground telegraph in Brussels. The wires were insulated with gutta-percha, and were laid in a trench and protected by earthern pipes only at the intersection of streets. This service only lasted four years, and in 1854 a new line was laid in a pine conduit. Renewed again in 1859, it was abandoned in 1866, and replaced by a line laid in cast iron pipes, split longitudinally. This arrangement permitted the direct laying of the cables, and the line is still in use. Two other lines comprise cables having metallic covering, laid directly in the ground. There are, says Mr. G. W. Roosevelt, no telephone or electric conduits in Brussels.

COPENHAGEN.

The telephone company of this city commenced in 1885 to use underground cables of the Felton and Guillaume type. These cables, which are protected by lead casing, were partly placed in the ground in iron conduits, and protected by an outer armature of iron wires. Two types of iron conduits were used, one being rectangular, and the other triangular; they were made in two parts, the conduits being made watertight by asphalt. These conduits did not prove a success, owing to their small resistance against injury by pickaxes, &c., whilst the mechanical damage to the cables was a serious drawback. After a few trials with wooden conduits, the company finally adopted, and put down a short length in 1888, béton (concrete cement) conduits. This type has since been extended, and has given satisfaction in every respect.

The Government Telegraph Department only uses to a small extent the underground conduits. The wires are contained in ordinary cast-iron pipes, of from 4 to 8 inches in diameter, and having sockets arranged at intervals of 160 feet, so as to draw in new lines, and to make repairs, &c.

As a rule, underground conduits are not used in Copenhagen for electric light wires, as insulated cables are in use which have an armature of lead and an iron lining—the iron hoop covered lead cables of the Siemens and Halske type. These cables are placed at a depth of about 2 feet 4 inches; on the top is a layer of sand $2\frac{3}{4}$ inches deep, and then a single row of bricks. The bricks and sand serve the purpose of calling attention to the presence of the cables, if the ground is subsequently opened. Only in a few streets are asphaltic lead cables used in place of those already mentioned. These are arranged in conduits formed of concrete cement, and are placed under the sidewalks, the top of the cover of the same material being at a depth of 10 inches and $12\frac{1}{2}$ inches from the curbstone. At street crossings the covers are strengthened by inlaid iron bars, $\frac{7}{8}$-inch in diameter, and the connections between the conduits are tightened with clay. The cables are placed in the conduits, which are then filled with clean sand, and the covers put on them; the object of the sand filling is to prevent gas from penetrating. A hole, $1\frac{1}{2}$-inch in diameter, is made at the bottom of each conduit, so as to lead away any water.

LYONS.

The only arrangements in this district for placing telegraph or other electric wires underground are in the larger cities, and in connection with the sewers. The wires are mainly insulated with gutta-percha, but to some extent they are encased in lead tubes.

MARSEILLES.

In this town and district there are no underground wires or cables for telephones or electric power. The telephone wires are carried overhead on poles across the housetops, or attached to the sides of the houses along the streets. The only conduits used are for telegraphic and electric light purposes. Five submarine cables land at Marseilles, and from the shore to the central telegraph office the distance is about five miles. Two of the cables belong to the Eastern Telegraph Company, and the other three to the French Government. The former are laid in iron pipes, at a depth of about 4 feet from the surface; the pipes are mostly old gas pipes, usually coated with asphalt. The wires for electric lighting are laid in the same manner as the telegraph cables, but are placed under the sidewalks.

NANTES.

No information is forthcoming concerning underground conduits for telephone and telegraph wires in this district, as being Government property the officials refuse to give any particulars. As regards electric lighting, this is being introduced by the Société Anonyme pour la Transmisaion de la Force par l'Electricité, who have not yet quite completed the laying of the cables. Two of the principal streets, the Opera House, and various cafés and stores, were electrically lighted for the first time in January last. The method employed is the continuous current system in conjunction with accumulators. There are semi-tubular boilers, three vertical engines, and three Desrozier dynamos. From the generating station the current passes to two storage batteries at a pressure of 330 volts. Both the feeders and the distributing mains are carried on porcelain insulators, which are soldered to cast-iron supports with sulphur; the bases, which are made in the form of a cross, are cemented with béton, and the wires are fastened to the porcelain by means of galvanised iron staples. In some parts of the town, however, there is danger at certain seasons of the bare wires being submerged in the conduits. In these cases insulated cables are used, and are placed in tubes coated with bitumen, called "Tuy aux Chameroy," from the name of the inventor.

The base and sides of the conduits are of béton, whilst the upper part is of schistose flagstone, cemented together with vassy cement. The conduits are laid either under the sidewalks or beneath the carriageway. They are all laid on an inclined plane, so as to allow the water which may penetrate, to drain into the town sewers. Manholes, surmounted by cast-iron covers, are built at intervals of 45 yards. The arc lamps used for street illumination are of the Lyo Bardon type, taking 8 ampères, and are suspended at a height of about 18 feet; incandescent lamps of the Cruto type and a few of the Grebriel system are used. The charge for current is 12 centimes (1¼d.) per hectowatt (100 watts). The city of Tours is almost entirely lighted by electricity, the mains being partly overhead and partly underground, the conduits being of the same type as that used in Nantes. The towns of Châteaulin, St. Brieuc, St. Nazaire, Hennebont and Saumer are partially illuminated by electricity, the conductors being carried overhead.

ROUEN.

In this town all the wires are aerial. The iron telephone wires and the copper electric light conductors, which are supported by porcelain insulators, are attached to the sides

and the roofs of the houses in the most primitive form. Lighting was commenced in 1886, and in 1888 the undertaking was converted into a company. The double wire method has been replaced by the three-wire system, at 240 volts, with Edison shunt-wound dynamos, in conjunction with accumulators. The charge for light is a fixed annual payment arranged on a sliding scale according to the candle-power of the lamps and the number of lighting hours per day, some lamps being energised up to 10 p.m., midnight, or 2 a.m. Each subscriber enters into a contract with the company for five years, and in consideration for this the company makes the connections and renews the lamps. The contract price covers the cost of installation, wear and tear, and supply of the current, other expenses being borne by the clients. The Pilsen and the Puteaux arc lamps, and the Edison-Swan and the Grebriel glow lamps are used.

BERLIN.

There are about 25,000 miles of underground telegraph wires in Germany, and this method is gradually being adopted in preference to the overhead system. The underground accommodations for telephone cables were completed principally in the years 1888-90, in Berlin and Hamburg. The arrangement of subterranean telephone lines in Berlin is claimed to be the greatest in the world, and the disposition adopted will allow of unobstructed development for many years to come. Cast-iron normal socket pipes are used, together with a large number of cable wells, which permit access to the pipes at any time ; and at street crossings, &c., wrought-iron boxing and masonry canals have been laid. This same system is followed out with the underground telephone wires in Hamburg.

BREMEN.

All telephone wires in this city are placed overhead, the wires being of zinced iron and of silicon bronze. There is one underground telegraph cable belonging to the State, and one underground electric light conduit, from which light is furnished to the warehouses, streets, dwellings, and yards of the free port. The cable is laid partially in cemented brick conduits, and partly in iron cases. The electric tramway, 5 miles long, is on the Thomson-Houston system.

DRESDEN.

Subterranean telephone and electric light cables do not exist here, but there are underground telegraph cables. These are protected against rodent insects, pressure, &c., by being passed through a casing of galvanised iron wires, varying in diameter according to whether for a land or a river cable. The cables are generally laid at a depth of 3 feet 4 inches under the sidewalks, and care is taken to avoid too close contact with gas pipes or cement, as it has been found that gas and cement destroy the gutta-percha insulation and imperil the cable itself. Usually a simple ditch is dug and the bottom carefully smoothed, and all stones removed. The cable is then laid in it (covered over with hard burned bricks when there are other pipes in the immediate vicinity), and the soil filled in. Cast-iron pipes are, however, used in streets where there is heavy traffic, or where it seems probable that the number of cables will be increased. Where the electric light is used, it is by individual plants of the consumers.

FRANKFORT.

The telephone wires here are strung, not through the streets on poles, but high overhead upon iron frames and posts projecting above the roofs of the highest buildings. There is no general system of electric lighting, isolated installations being the rule where electric light is used. The telegraph wires are all laid underground in the form of cables. These are made solely for Government by Siemens and Halske and Felton and Guillaume, both of whom are said to be "opposed to subterranean conduits for electrical purposes." This opinion has so far prevailed that Frankfort has made no formal experiment with any system of conduit.

THE NETHERLANDS.

The telegraph wires in the Netherlands are laid partly in iron tubes, and partly in asphaltum tubes and clay pipes, whilst fully 75 per cent. comprise cables. All of these connect the Government telegraph stations in cities with the aerial wires used in the country districts. The only method now applied is the underground cable, laid about 2 feet 6 inches in the ground, with no other protection than the earth. Electric lighting has not been much adopted, whilst for power purposes electricity is not used.

ITALY.

The telephone company for central Italy, with an office in Florence, and branches at Bologna and Leghorn, does not use underground conduits. In Milan, the electric light company has about 22 miles of underground mains.

LISBON.

With the exception of about one mile of electric light wires laid in the main avenue, there are no underground conduits for telephone, telegraph, or electric power cables in this city.

BARCELONA.

The only wires laid underground are those for private electric lighting, and the cables of the Government, and of the Direct Spanish Telegraph Company's telephone and telegraph wires, and the conductors of the electric light company for lighting the 200 arc lamps of the city, are all suspended in the air. With the exception of the latter, all the cables of the electrical company are placed underground, at a depth of 2 feet under the sidewalks. The cables are laid in pipes, and service boxes are arranged every 60 yards. It is proposed to construct subways for the accommodation of all the pipes and wires in the city.

STOCKHOLM.

Telephone, telegraph and electric light and power cables have hitherto been carried overhead ; but recently the State Department for telegraphs has introduced an underground system, the invention of A. Hultman. The method consists of blocks of cement (each containing several pipes) joined together by means of long iron bars, and the interior of the pipes greased with some mixture to diminish vibration. No iron pipes are used, and the method is said to be very cheap. The process of laying down the system is proceeding. Both private companies' wires are overhead.

THE "ELASTIC MEDIUM" METHOD OF TREATING ELECTROSTATIC THEOREMS.

IT is usual to deduce the ordinary theorems of electrostatics from the law that two amounts of electricity repel one another with a force proportional directly to the product of these amounts, and inversely to the square of the distance between them. Faraday pointed out that the results so deduced, and confirmed by experiment, could be explained by assuming the existence of an elastic medium, the straining of which was electrification, and the consequent stress, electrical force. The elastic constant of such a medium Maxwell proposed to call the "coefficient of electric elasticity." Dr. Lodge has used the idea with conspicuous results in his book on "Modern Views of Elasticity."

The reading of Dr. Lodge's book has doubtless suggested many fruitful trains of thought in many minds, and such appears to have been the case with Prof. W. H. Bragg, M.A., of the University of Adelaide, South Australia. He contributes to the *Philosophical Magazine* a paper, 18 pages long, in which he seeks to draw attention to the advantages that are to be derived, especially by the student, from taking as an hypothesis, not, as is usual, the law of the inverse squares, but the existence of Faraday's "elastic medium."

The hypothesis may not be exactly true, but it is as nearly true, and in the same manner true, as that a wave of sound may be represented by a wavy line. And Prof. Bragg argues that we have as much right to deduce theorems of electrostatics from consideration of the behaviour of this medium under stress, as to deduce the laws of the interference of sound from the summation of waves on a diagram. In both cases the whole truth is not presented ; but what is given is sufficient to ensure the accuracy of the deduction.

Suppose, then, the existence of an incompressible perfect fluid, filling all space and all bodies—the æther. Suppose that in some bodies—copper, silver, &c.—this fluid finds no

opposition to its motion ; but that in others—air, glass, silk, &c.—the particles of the body are so entangled or embedded in the fluid that the fluid cannot move without carrying along the particles with it ; and that whenever any displacement of the medium takes place a force of restitution is called into play, proportional to the displacement, to the amount of the moved particles, and to a quantity depending on the nature of the body in which the displacement occurs. This last quantity is Maxwell's coefficient.

In making these suppositions, we are not laying upon that maid-of-all-work, the æther, any burden other than those she has for various purposes been already taught to bear.

Suppose, further, that a positive charge of electricity corresponds to the forcing of an extra quantity of æther into the charged body, and a negative charge to the withdrawal of part of the æther the body contains. Then it is easy to show that phenomena similar to those ordinarily ascribed to the attractions and repulsions of electrified particles must occur.

With these assumptions, Prof. Bragg proceeds to show that the results deduced from the ordinary hypothesis and the hypothesis of the elastic medium correspond exactly, taking a number of test theorems and considering them from both points of view. Indeed, he seems to succeed in showing that the "elastic medium" theory is superior to the other in explaining the distribution of charge on an ellipsoid.

In connection with this paper, which will be read with interest by students of the theory of electricity, it is worth noticing that the method employed leads to a most simple proof of the law that a closed conductor perfectly screens its interior from the action of external charges. For the only way in which the pressure of the æther in the conducting shell could affect the dielectric (uniform or not) in the interior, would be by changing the shape of it, pushing it in some places, and therefore allowing it to bulge out in others. But since the pressure is uniform over the conductor, and the interior of the shell is unalterable in volume, no work is done by any such deformation. Hence no energy can be imparted to the interior of the conductor, and consequently no changes can take place ; every forced change would, of course, require energy to produce it.

Amongst the advantages of this method of treating electrostatic problems are the following :—In the first place, it is possible to form a mental picture of the physical meaning of every step in the mathematical reasoning, and, therefore, it is easier to understand the step, to remember it, and to give it its proper relative importance ; moreover, the mathematical reasoning itself is much simplified in the case of some of the problems which Prof. Bragg deals with in his paper. Again, the expression for specific inductive capacity appears in every equation, as it should do, and its significance is at once comprehended ; the idea of this quantity, or of the electric electricity, is often very hazy when formed from definitions of the ordinary method. Further, the method offers a new standpoint, the view from which makes clear, at least to the student, many things that were confused before, and greatly assists in giving an insight into modern advances in the theory of electricity.

TRIAL OF THE CHEMICAL THEORY ON LEAD ACCUMULATORS.

ALTHOUGH most of the scientific journals have given analyses of the paper presented at the *Société Internationale des Electriciens*, at the sitting of May 4th, I (M. Darrieus in *L'Industrie Electrique*) thought it would be worth while to give some explanations with regard to a subject bringing to light new ideas, if it were only to mark more emphatically those points to which I wish to call the attention of all those engrossed in the accumulator problem.

Since the researches of their originator, Gaston Planté, the chemical theory of lead accumulators has been studied by a number of experimentalists ; but whilst in the *Recherches sur l'Electricité*, we see that the principal reactions have been so to speak, guessed at, if not thoroughly established, it seems as if the question had gone back a step in the most important articles published on the subject in France and other countries.

Various hypothesis have been suggested, more or less ingenious. I will content myself with referring to the one that has up to the present been most in favour, notwithstanding the fact that it was opposed to the laws of electrolysis, the double sulphating theory.

The most powerful argument in its favour rested on the experimental fact that we always find sulphate of lead on the two electrodes after a discharge ; we shall presently see why this argument is only a superficial one. With this theory, as with all the others, the main idea has been to make the phenomena observed agree with Thomson's law, starting with the electromotive force given by calculation in order to deduce the probable reactions in accordance with this law.

To show the defective side of this method, I need only remark that it is precisely for all the voltaic combinations, the reactions in which are not exactly known, that the formula does not give figures similar to those obtained by experiment. As the lead accumulator belongs to this class, is it not more in accordance with scientific research to seek before all, with unbiassed judgment, the chemical law of the working, and only then to apply the thermo-chemical law.

This is the method which I have systematically followed, without prejudice, agreeing entirely with my friend J. Sarcia, whose great experience has been so useful to me in the discussion of the experimental results.

Without entering into the details of the experiments for which I refer my readers to the *Bulletin de la Société Internationale des Electriciens**, I will content myself with summing them up, merely noting their conclusions.

What is at first the constitution of the accumulator after a charge ?

The method employed for finding out the nature of the plates consists in treating samples taken out by the same process of analysis and comparing the results with determined weights of material obtained chemically. We find in the first place that the negative plate is nothing but soft and very porous lead ; it only differs from ordinary finely divided lead in that it possesses reducing properties not met with in the latter, and has a great aptitude for becoming oxidised. The positive active material is formed of peroxide of lead impregnated with a hyper-oxygenated liquid which is found to contain persulphuric acid.

Of what nature are the modifications observed in the molecular condition of the plates in consequence of the discharge ?

In accordance with the known laws, the negative material is oxidised and the oxide transformed into sulphate, as with the phenomena observed with most voltaic combinations ; the analysis of this active material shows a quantity of sulphate of lead ; *always a function of the discharge*. The density of the liquid diminishes during the discharge and the quantity of acid that has disappeared corresponds within a very little to that fixed on the lead of the negatives to form the sulphate ; these two results verify one another.

The peroxide of the positive plates has been partly transformed into an inferior oxide and the quantity of this oxide is always a function of the ampère hours of the discharge. This being admitted, if we seek, in order to confirm the hypothesis of the sulphating of the positive admitted by so many writers, sulphate of lead in this positive, we find that it really does exist, but in quantities that are essentially variable and in all cases never in proportion to the ampère hours obtained.

The formation of the sulphate must therefore necessarily be attributed to some local action, and this is proved by the fact that if we proceed to seek for this sulphate on a sample of positive material taken out after the discharged accumulator has been at rest sufficiently long, the quantity of sulphate of lead found is much more considerable and has become proportionate to the quantity of electricity produced.

Thus we can no longer have any doubt about the matter and it is in this fact that we must seek the explanation of the hypothesis of the sulphating of the positive, the various experimentalists having systematically worked for the most part on samples after a long period of rest, and consequently, inevitably finding sulphate. Moreover, we can understand that to get exact results from analysis, it is indispensable to proceed directly after the breaking of the current, so as to seize the material, so to speak, before there is time for any local action to be set up.

* See also ELECTRICAL REVIEW for June 10th, 17th, and 24th.

All this agrees absolutely with Planté's views, he having recommended for the formation of his plates, that the accumulators should be allowed to remain at rest, so that the sulphating of the material might be effected simply by local action.

In short, then, the working of the lead accumulator resolves itself into that of a simple battery in which the metal consumed is lead and the principal depolarising agent bioxide of lead, the persulphuric acid intervening only during the short period of the *coup de fouet*.

Notwithstanding the simplicity of this voltaic combination, several points remain obscure :

1. Why does ordinary soft lead, put in the place of the negative metal, give no appreciable result ?

2. How can we reconcile the apparently contradictory facts that the sulphate is useful during the discharge, while it is such a long and difficult task to make it disappear when it is completely formed upon the plates ?

3. Lastly, how is it that, considering the well-known nature of the plates, the application of Thomson's law does not give a value in accordance with the measurements. Questions 1 and 3, may be answered by the same explanation that applies to the peculiar molecular state of the negative metal ; this lead is always reduced from a salt by an electrolytic, or simply a chemical process, and is obtained either directly from this salt or produced little by little at the expense of the metal as by Planté's method. This lead is in an allotropic state which gives it peculiar properties ; it is easily oxidised and gives off heat on passing to its ordinary state, which makes the measurements agree with Thomson's law.

And it is to the peculiar nature of the negative metal that we owe the elevation of the electromotive force, for it is sufficient, in a voltaic combination formed of Pb O^2 and ordinary soft Pb, to substitute for the plate of soft lead another of porous lead, obtained by reducing chemically a salt of lead by zinc, without any charging operation, in order to see its original electromotive force rise. What we have agreed to call the *formation* of an accumulator, will henceforward consist in obtaining that particular state of the lead that brings about the same final result, whatever may be the process employed.

I have undertaken a fresh series of experiments intended to show the important part played by this molecular condition of the metal, which I shall describe later.

The second doubtful point is cleared up by considering that the part played by the ordinary soft lead is not the same as that played by the negative lead ; with the ordinary lead the sulphating is entire, and the veil of non-conducting salt formed arrests all contact with the underlying metal.

On effecting a discharge from a well charged accumulator into a neutral solution of sulphate of soda, we find by analysis that the negative material discharged contains sub-oxide of lead ; such would be therefore the principal reaction, the sulphating taking place after the discharge.

Now, sub-oxide when heated with sulphuric acid gives rise to metallic lead and sulphate.

Each molecule remaining would act as a conductor for a molecule of sulphate ; we see then why it is such a tedious process to desulphate plates in which this conducting envelope is itself sulphated.

Such are the main lines of a study in which I have tried to group some conclusive results, and, as all research should yield some useful and practical teaching, we may draw from the above conclusions an effectual method of preserving accumulator plates when they have to remain long without being used. They are generally kept in dry air or distilled water ; in both cases the negatives are sub-oxidised, the positives are slightly carbonated and give rise to sulphate of lead when they are immersed in acidulated water. The first methods used for desulphating are long and tedious, they involve in every case a useless loss of money and time. The most rational mode of procedure is to carefully wash the plates after the last charge, and then to mount the accumulator in a neutral solution of soda (they can remain like this indefinitely), and lastly, before using it again to effect the first charge in this sulphate of soda, so as not to add the acid liquid until after this first complete charge.

A long experience of this method enables me to recommend it strongly.

ON THE DIFFERENCE OF POTENTIAL AT THE CONTACT OF MUTUALLY RE-ACTING LIQUIDS.

In 1889 Mr. J. Brown began an investigation into the difference of potential at the contact of liquids, including aqueous electrolytes, with the object of determining the connection, if any, between this difference of potential and the chemical re-action of the liquids on one another. The work is not yet complete, but for certain reasons Mr. Brown has published such results as he has obtained in the June number of the *Philosophical Magazine*, pages 532—539.

The method employed was a modification of that of Exner and Tuma (*vide Sitzungsberichte d. Kais. Akad. Wien*, xcvii., Part II., p. 1) in their experiments on the contact potential of metals and liquids, but it was modified to the extent of using a water-dropping testing funnel in order to avoid irregular indications.

The first few experiments made were based upon the assumption that, as the oxidation of a metal by an electrolyte electrifies the metal negatively, the raising of a salt from a lower to a higher oxide or chloride might have the same effect. The results contradicted the hypothesis in every instance but one.

A number of experiments were made in the hope of gaining some insight into the kind of results to be obtained from the contact of two solutions (containing equivalent proportions), between which double decomposition occurred on mixing. The results were only tentative, but in so far as they may be considered approximate, they suggest the following conclusions :—

1. There is no clear connection apparent between the observed electromotive forces and the heat equivalents of the re-actions ; but the amount of water present seems to have an effect either by the dilution of both solutions equally, or one more than the other.

2. The sign of electrification may depend, however, on the following considerations. When double decomposition occurs at contact of solutions of two substances, one of which consists of an anion a and cathion c, and the other of an anion a' and cation c', the products of the reaction being $a\,c'$ and $a'\,c$ then the solution $a\,c$ will be positive if the combining heat $a'\,c$ is greater than $c'\,a$; and *vice versâ*.

But although Mr. Brown supports this hypothesis with many valuable experimental data, he admits that it can scarcely be regarded as more than tentative, pending experiments under conditions of a more varied character.

From a consideration of the large and striking character of the results obtained by Bichat and Blondlot in 1883, by Ayrton and Perry in 1880, and by Exner and Tuma, all of whom have avoided ignoring the electrolytic or voltaic effect of any action between the liquid and the immersed pole—a condition which introduces an unknown amount of error—Mr. Brown has been led to test a series of pairs in which acids and strong aqueous solutions of various kinds were tried against water, with the object of ascertaining whether the observed effects have any connection with the heats of solution or dilution of the substances. The results are given in a table, and a comparison of numbers shows that in the case of positive heats of solution there is a rough agreement between their amounts and those of the observed electromotive forces, while with negative heats the results appear variable and indefinite.

Mr. Brown has also obtained some interesting evidence bearing on an hypothesis current among German physicists, which, premising that the ions are oppositely electrified, states that "water must show against every electrolytic solution the potential of the faster ion." The evidence, however, does not support the theory.

The Electric Light at Rugby School.—At a meeting of the Rugby Local Board last Saturday, an application was made on behalf of the governing body of Rugby School, for permission to lay an installation of the electric lighting plant to light the whole of the school premises and the boarding houses. The application was granted. Several fires have occurred at the school in consequence of gas, and the decision to adopt electricity is said to be mainly due to this and economic causes.

ELECTRIC RAILWAY MOTOR TESTS.

BY ALBION T. SNELL.

THERE is no little diversity of opinion among experts as to the relative merits for tramcar work of single, double, and gearless motors; of regulation by rheostat and by commutated field winding, and the use of one or two motors. Probably the reason why these points have not yet been settled is that the running of a car is so much influenced by the conditions of the track, road and service that comparative data are scarcely possible. It seems probable also that the several systems or devices may give equally good results under certain circumstances.

In April last, Mr. H. F. Parshall read a paper entitled, "Methods of Electrically Controlling Street Car Motors." This gentleman discussed at length the rheostat, the commutated field, and a combination of the two; and he seems to infer that the latter arrangement is meeting with the most success at present. In American practice, it must be recollected that two motors of 15 B.H.P. each, are almost invariably used on the ordinary sized street cars; and so the "Series Parallel Method" is applicable, and is being tried with some success. In this arrangement the motors are coupled in series with each other and also in series with a resistance of from 8 to 20 ohms at starting, and when the car has attained some velocity they are thrown into parallel. This seems simple enough, but, really, it involves considerable difficulty. The procedure is as follows: after the external resistance is thrown out of circuit, the magnet coils of one motor are short-circuited, one section at a time—some three or four coils being necessary to make the start smooth. This being done the armature of the same machine is also short-circuited, and the field coils are thrown into circuit again simultaneously as the armatures are coupled in parallel. It is just at this point that the difficulty occurs, for no matter how quickly the switch lever be moved, if the contacts do not work exactly in unison there is a strong probability of short-circuiting the mains. Mr. Holroyd Smith has lately tried a similar arrangement at Bradford, and has been very successful; but he apparently opens the main circuit before changing the coupling of the motors. This seems to be the proper method, and obviates all chance of short-circuits.

Recently the question has been investigated by Prof. G. D. Shepardson and Edward P. Burgh, who have published in the *Electrical Engineer*, New York, for July 13th, a very interesting and complete set of brake tests and other data anent the subject. At the commencement of their paper these gentlemen state that it is commonly understood that electric roads using rheostat regulation require a larger capacity at the generating station than those using commutated fields; and yet on one large road rheostat regulation has just been substituted for the other method. So, feeling the general uncertainty on the points at issue, and the difficulty of obtaining reliable information, they decided to make a series of independent tests. The experiments were chiefly conducted by Mr. Burgh in the repairing shops of the Minneapolis Street Railway Company, the master mechanic of the tram company, Mr. William Cooper, assisting. The machines tested were a No. 6 Sprague double reduction motor, of the type described by Mr. Parshall in his paper already referred to in this article; and a Thomson-Houston single reduction motor, wound for 500 volts.

The efficiency in each case was taken between work on the rolling wheels, and the energy given to the motor. To accomplish this the rolling axle was removed and a short shaft fitted in its place, carrying at one end a heavy cast-iron wheel, around which was fitted the Prony brake. A Thomson-Houston rheostat, and the usual commutating switch were used to make the different arrangements in the couplings. It was found that the Sprague motor and gearing under these conditions gave an efficiency of conversion of about 82 per cent., with an output of from 6 to 8 H.P; while at 3 H.P. the efficiency was 65 per cent.; and at 15 H.P., about 73 per cent.

This all round conversion is better than one expected, and speaks well for the double reduction motor.

The single reduction Thomson-Houston machine was tested under identical conditions, with the following result:—

Output of 3 H.P. efficiency = 55 per cent.
" 7 to 8 H.P. efficiency = 77 per cent.
" 13 H.P. efficiency = 58 per cent.

The single reduction motor appears to be inferior to the double reduction one in efficiency all along the line. This one is led to expect from theoretical considerations; but the average difference seems to be excessive — perhaps the particular motor is not a fair sample. Of course the question of durability is not affected by this test.

Mr. Burgh finds the rheostat method, on the whole, to be superior to the commutated field, and he says: "The heat developed by $c^2 R$ can be cared for more easily and cheaply in an open rheostat than in the field coils. Rheostats of iron and mica are cheaper and more heat proof than cotton-covered wire. This forces the conclusion that for the heavy load due to accelerating the car at starting, the field should have the smaller number of turns, and as the car reaches normal speed, and the H.P. and current become less, the efficiency of the motor can be raised by increasing the number of turns." "This," he goes on to say, "is the converse of practice with manufacturers to-day, who sacrifice some efficiency for speed at small outputs. It is also in line with the experience of the road mentioned, on which the commutated fields were replaced by single coils of No. 7 wire, and afterwards with No. 5 wire. The average efficiency was raised by using the two motors in series at the start, and afterwards cutting out one, or putting the two in parallel, if necessary, as the speed increases and the H.P. decreases."

This return to the simple series wound machine, with a starting resistance, is in accord with the experience gained in England; and despite the loss made in the rheostat, it seems that this method most nearly meets all the difficulties of street railway work.

It was also noted that a single motor gave better results than two in parallel. The mean of twelve readings showed a diminution of 27 per cent. of current by using one motor instead of two, which confirms the experience the writer had at Liverpool some two years ago with a 12 ton car fitted with two motors. He found that when the motors were run in series, the power absorbed was less than when coupled in parallel by some 15 or 20 per cent., although the two machines were as nearly identical as possible.

It appears, therefore, that although the "Series Parallel Method" offers some advantages in the regulation of speed in crowded thoroughfares, the efficiency is not likely to be so high as that obtainable with a single motor, and it may reasonably be doubted whether it will come into general use.

The experimenters have, also, plotted some interesting and valuable curves connecting horizontal effort with car speed, torque with horse-power, &c., the study of which will repay tramway engineers.

The author has on several occasions stated his opinion that the car of the future will have only one motor, will be started through a rheostat, and that the reserve of each car will be the one following it; he also thinks it probable, in the light of modern experience, that the line pressure will be lowered from the 500 volts now in vogue to 250, or thereabouts. The tests of Mr. Burgh support these views.

ELECTRIC LIGHTING IN ISLINGTON.

THE report of the committee appointed by the Vestry of St. Mary, Islington, to obtain information on the cost of electric lighting as compared with gas, and to consider the advisability of the vestry becoming the undertakers for the electrical supply, was, as stated in our last issue, decidedly in favour of the vestry applying for a provisional order; this conclusion being arrived at with the aid of a report by Prof. Henry Robinson, and being, no doubt, much helped on by the favourable impression which was made on the occasion of the committee's visit of inspection to the St. Pancras Central Station. The system proposed for Islington is the same as that in use at St. Pancras, viz., low pressure continuous current with supplementary batteries; and it is estimated that the two stations required to supply the district can be erected and fitted with plant capable of supplying current for 12,000 lamps of 16 candle-power for the sum of £50,000, and that

5½ miles of mains will be required, which will cost £35,000, or a total of £85,000 in all.

Although we do not desire to enter on any discussion as to whether the system proposed is the most suitable for the district, as this can only be done after a careful consideration of the various local conditions; yet we cannot help thinking that the claims that the committee have put forward for this system in their report are singularly ill-chosen, since we see it stated by them that "the main advantages claimed for this system are the cheapness of the conductors as compared with the cost of the highly insulated cables used for the high tension system, and the ease and simplicity with which it can be worked, in consequence of the employment of currents of low pressure." We have always thought that it was precisely in this matter of the capital outlay on conductors, that the high-pressure companies had the advantage, and that this was allowed to be the case even by the most ardent champions of low-pressure systems, but perhaps the committee have been informed that the cost of copper laid in a culvert was less than that of an equal weight of copper laid in the form of an insulated cable, and whilst accepting this, have failed to grasp the fact that the weight of copper on the two systems is not quite the same. With regard, also, to the ease and simplicity of working, many engineers will disagree with the statement in the report, since it is well known that an extended three-wire system entails far more elaborate switchboards and regulating apparatus than an alternating transformer system.

A great portion of Prof. Robinson's report is occupied with two most important questions, viz.: the price at which the vestry would be able to supply current, and the relative cost of lighting by gas and electricity, and in both cases we consider that the conclusions arrived at are, to say the least, too sanguine. The report says: "The working expenses only form a small proportion of the total annual cost of an electric light station, because there are permanent establishment charges for management as well as provision for maintenance, depreciation of plant, and sinking fund, which are unalterable. In connection with the two proposed stations, these fixed charges would amount to about £10,000 per annum, while the variable expenses (for coal, labour, &c.) only amount to about 1·8 pence per unit." This figure for the cost of coal, labour, &c., is for the time when the stations are fully loaded, and is calculated on the assumption that the annual consumption per 16-C.P. lamp installed is 40 units; but if a comparison be made between this estimated figure, and the published costs of other London stations working on a similar system, it will be found that it is about 10 per cent. lower than the cost in 1891 at the St. James' station, although the annual consumption was at the rate of about 68 units instead of 40 per 16-C.P. lamp, and that it is about 30 per cent. lower than the average for the St. James', Kensington, and Westminster stations, which together give an average annual consumption of just about 40 units per 16-C.P. lamp.

Let us assume, however, that this figure will actually be obtained, we still fail to see how a charge of 6d. per unit (with a reduction for long hours) for the first year, and afterwards a charge of 5d. per unit will be sufficient; as 40 units for each of the 18,000 lamps wired (that being the number named by Prof. Robinson) gives an annual output of 720,000 units, on which the fixed charge of £10,000 works out at 3·33d., and the total cost at 5·13d. per unit, or rather more than the price at which it is to be sold after the first year; whilst, as regards the first year's working, the output would require to be nearly 600,000 units to bring the cost down to 6d., and such an output would require an average of about 14,000 lamps fixed. We presume, however, that it is not proposed to debit the first year with its share of the fixed charges; but if this is so, the report hardly makes it clear, as it says that no contribution from the rates would be involved, even during the initiation of the business.

With regard to the relative cost of gas and electricity, Prof. Robinson says that the cost of the electric light is about the same as gas (which costs 3s. 1d. per 1,000 cubic feet) when the current is charged at 5d. per unit. The data on which he makes this comparison are that a flat flame burner giving 12 C.P., burns 4·6 cubic feet of gas per hour, and that a 16-C.P. incandescent lamp requires 56 watts to maintain it at this candle-power. Now, even if we accept these figures, the result is not so favourable to electric lighting as stated in the report, since the cost of gas (at 3s. 1d. per 1,000) is ·23d. per hour for 16 candles, whilst the cost of electricity (at 5d. per unit) is ·28d., to which the report rightly says should be added ·045d. per hour for lamp renewals. These figures show that gas at 3s. 1d. per 1,000 is equal to electricity at about 4d. per unit, if the cost of current only is considered, or under 3½d. per unit if we include renewals. But one may well ask where is the incandescent lamp which will give 16 candle-power for 56 watts during a life of 1,000 hours. The Vienna tests (published in the ELECTRICAL REVIEW of October 17th, 1890, by Mr. Dobson), which are the most favourable tests we have seen, certainly gave this efficiency for the lamp at the start; but even in this matter of initial efficiency, other tests, such as those recently made at the Central Institution, point to a higher consumption. However, taking the figures of the Vienna tests, we find that instead of 3·5 watts per candle, we must take 4·25 if we wish to burn the lamps for 1,000 hours before renewing them, so that 16 candles will require 68 watts instead of 56, and the cost per hour for current, at 5d. per unit, will therefore be ·34d. instead of ·28d., which is equal to gas at 4s. 7½d. per 1,000.

To supply electric light at a cost equivalent to that of gas at 3s. 1d. per 1,000, would require, not that the charge should be 5d. per unit, but that it should be rather under 3½d. per unit, if no allowance is made for lamp renewals, and about 2¾d. if the cost of renewals is included, and we must protest therefore against such statements being made in the reports of consulting engineers, as, sooner or later, their effect will be decidedly harmful to the progress of electric lighting. It would surely be far better to quote figures about which there can be no doubt, so that vestries and other public bodies may not be disappointed of the results promised them, and to rely on the undisputed advantages of electric lighting from the point of view of cleanliness and convenience to make up for the disadvantage of its greater cost as compared with gas.

THE CANADIAN ELECTRICAL ASSOCIATION.

THE first convention of the recently formed Canadian Electrical Association was held last month at Hamilton, and was well attended by representatives of all branches of the electrical industry in the Dominion. The objects of the Association, as explained by the president, Mr. J. J. Wright, in his opening speech, are to look after the interests of the electrical trade, both from the scientific and commercial standpoint; the functions of our Institution of Electrical Engineers and of the Electrical Trade Section of the London Chamber of Commerce being combined and undertaken by this one Association, which, besides arranging for the reading and discussion of papers at its conventions, has appointed permanent committees for the purpose of collecting statistical information, and of keeping a watch on all proposed legislation which may affect the trade.

The convention lasted for three days, one of which was occupied with business connected with the organisation of the Association, whilst the other two were devoted to the reading of papers on various subjects, and to one or two visits to places of interest, such as the Telephone Exchange and the Central Lighting Station. One of the most interesting of the papers was one by Mr. Parker on "The Financial Aspect of Electric Lighting," in which, whilst congratulating the new world on its greater progress as compared with the old in the matter of street lighting, the author gave it as his opinion that the financial results to those who had invested their money in the business were as a general rule by no means satisfactory.

This conclusion was the result of an examination of data supplied to the author by the owners of 25 lighting stations in various parts of the country, and was confirmed by figures collected by Mr. Yule, of Guelph, a brief summary being as follows:—Of the 25 stations referred to, 13 used steam power only, nine used water-power only, and three used a combination of steam and water-power; only 15 of these stations were paying a dividend, and of these eight used water-power only, two used steam and water, and only five used steam alone. The capital invested in these plants

amounted to just a million dollars, and more than half of this capital had failed to earn a profit, the actual proportions being that $400,000 had paid a dividend, whilst $600,000 had not. From an analysis of the returns of these stations, Mr. Parker comes to the conclusion that a steam power plant must charge about 40 cents per all-night lamp per night (say £30 per annum), in order that it may earn a profit, and that water-power plants can afford to charge from 10 to 12½ per cent. less. If these figures are correct, it is not surprising that the financial results are unsatisfactory, as in a table published in the paper, giving the prices charged per lamp per night in various parts of Canada, we find that there are only three towns in which the charge is 35 cents or more, and that these three towns only represent about 180 arc lamps out of a total of nearly 3,000 included in the table.

The data collected by Mr. Yule showed that out of 52 stations, only 30 were paying a dividend, and that of this number 15 were engaged in other business carried on during the day; whilst of the remaining 22, some were so far from earning a profit, that they were not even paying their working expenses. It appears from the paper, that a similar state of affairs exists to some extent in the United States also, notwithstanding the fact that the prices obtained there are, on the average, higher than in Canada; and Mr. Parker therefore concludes that he need not be considered a pessimist when he says that the present state of affairs cannot last for any length of time, and that some change must be made, and that quickly, so that the capital invested in this business may earn a reasonable profit. One direction, in which he looks for an improvement, is in a closer union of central station men with a view to stopping the senseless and ruinous competition so often indulged in, and another is in the employment of the plant during the day for the supply of electricity for motive power. This latter method of lowering the cost is often spoken of in England, but so far has hardly got beyond the region of talk, even with the low pressure continuous-current advocates, who bring forward the possibility of using motors on their circuits as one of the great advantages of their system; the reason being that at present there is practically no demand for current for this purpose. But even if the demand existed, it still remains to be proved whether or not it would materially aid the finances of supply companies, owing to the overlapping of the hours during which the motor load and a heavy lighting load would be on; and on this account the experiment which is being started in St. Pancras, of supplying current for motive power at a lower price will be watched with considerable interest.

Two other papers which were read are of interest as showing the opinions of leading Canadian electrical engineers, on the question of the best type of engine for central station use in Canada. Mr. Thomson, in a paper on "Central Stations," says that there can be no doubt that, in stations of any considerable size, the most suitable engines for the purpose are what are known as cross-connected twin engines of slow speed, and that such engines can be operated at a considerable saving over the best high speed engines that are manufactured; whilst Mr. Wright, in a paper on "Steam and Electric Power," says, "I am not going to thresh out the obsolete controversy of high-speed engines *v.* slow speed. That question has been settled long since. Be moderate in all things. While you are avoiding the high-pressure steam eating flyer on the one hand, do not go to the other extreme and build an unwieldy engine that makes one revolution to-day and another to-morrow;" and again, "Let your engines move lively but at a reasonable speed, say from 85 to 90 revolutions for a 250 or 350 horse-power engine." It is probable that these remarks refer more to engines for arc light and power stations than to engines for incandescent lighting, and that the conditions of working differ very much from those obtaining in English central stations; but it is evident that in Canada the high-speed engine is not in good repute, and that engineers are more in harmony with continental practice, as regards engine speeds, than with that so generally adopted in England.

The Canadian-Pacific Telegraphs.—The *Financial News* states, on the authority of the *Herald*, that the directors of the Canadian Pacific Railway Company have refused an offer of two million pounds sterling for their telegraph system.

A CONTRIBUTION TO THE CHAPTER ON ACCUMULATORS: GUARANTEE.

[FROM OUR OWN CORRESPONDENT.]

As it is well known, the opponents of accumulators almost always allege, as their most essential defect, their slight durability and their extremely delicate action, which makes the use of accumulators very complicated and costly. The former defect was simply denied by the friends of accumulators, whilst the second charge was met by the statement that the suppliers gave an unconditional guarantee for one year, and declared themselves moreover prepared to undertake, for a relatively modest premium, to keep the accumulators which they supply in good condition. This proposal was very inviting for the general public, because hereby the risk as regards durability was for a fixed sum turned over to the maker. The Vienna General Representative of the Joint Stock Company for the Manufacture of Accumulators (Tudor system) has lately sent out to its customers a circular, which in view of the situation above mentioned, deserves very particular attention, and will give many persons cause to meditate on the value of the guarantee obtained. This circular is textually as follows:—

"We have lately had frequent cause to perceive that our instructions for the management of accumulators—or for 'tending' them—though easy of execution, were still not conscientiously followed out on the part of the attendants.

"Personal changes often take place among them without the new comers being made sufficiently acquainted with the most important instructions.

"In your own interest, therefore, as also in the interest of the good name of our accumulators, we address to you the following request:—

"1. To call the attention of the tender emphatically to the injurious consequences which must certainly result from the non-observance of our easy instructions.

"2. When the tender has to be changed to inform us as soon as possible, so that we may send down one of our men in order to give the new man sufficient instruction. Of course, this latter point is necessary only if you, or one of your staff, is not in a position to instruct the new comer sufficiently.

"If it appears from our revision that the small work of attending to the battery is not performed at all, or not carried out completely and in the right manner, and that the daily reports are not filled up from conscientious observation, but merely superficially and as a matter of form, we can neither fulfil our stipulation to keep the accumulators in order for one year, nor that of maintenance after an insurance has been effected.

"We can then undertake the operations needful for putting the battery in order exclusively at the cost of the possessor, since we cannot be expected to bear material injury in addition to the moral damage arising from the deterioration of our batteries not occasioned by our fault.

"We therefore courteously request persons ordering or possessing batteries in their own interests to take good care that our instructions for working and minding are conscientiously followed out, and that the daily reports, authenticated with the signature of the possessors, are sent to us regularly.—Respectfully,

"General Representation of the Accumulator Co. of Vienna.

"*June*, 1892."

The contents of this circular must certainly be described as outspoken, and honest in its intention. But if the honesty of such language may heighten subjective confidence in the suppliers, it is a quite different question how such a circular will affect the confidence of the general public in the practical industrial value of the accumulators.

The circular has further a great defect: it is not said what are the instructions on the observance of which the company makes the fulfilment of their guarantees to depend. The Accumulator Company has published a pamphlet entitled "Description, Erection, Treatment, and Connection of Accumulators," with instructions as to their management, and we should expect that the circular refers to these instructions. Such, however, are not calculated to encourage the public to purchase accumulators from the simple reason that these instructions and descriptions extend to 190 printed pages!

THE FIRST ELECTRICAL FURNACE FOR THE FUSION OF METALS.

In the present article the writer proposes to call attention to a patent which must really be considered as the first effort to make an industrial application of the heating effects of the electric current for the fusion of metals or the reduction of ores. The text of this patent is as follows :—

Patent for 15 *years, taken out by M. Gustave Saint Amand Pichon, chemist, at the School of Practical Chemistry, living in Paris, Rue de Vendôme, No.* 16 (*No.* 15,880), *dated March* 16*th*, 1853, *for an economic and general application of the electric light to metallurgy and principally to the metallurgy of iron for the fusion and reduction of all kinds of ores and metals in place of all kinds of fuel.*

By using the electric light in the metallurgy of iron, we diminish the height of the furnaces known as high furnaces, the height of which is 8, 10, 15 and even 18 metres ; and we substitute for them furnaces 4, 5, or at the most, 6 metres high. And we, consequently, reduce by $\frac{1}{2}\frac{9}{0}\frac{9}{0}$ths the enormous quantity of fuel that we are obliged to use with the high furnaces.

We mix the iron ore as at all iron works, clay ore, quartz ore, and calcareous ore or carbonate of lime if we have no calcareous ore ; and, if expedient, we add $\frac{1}{1}\frac{}{0}\frac{}{0}$th of coal and coke dust.

We proceed as follows :—We arrange in the opening, O, one, two or more systems of carbons, conical at one end ; these carbons are made on purpose, in the same way as those used to produce a small light, either for public lighting or private exhibitions. These carbons, shown in fig. 1, are prisms with a square base of 60 centimetres and a length of 3 metres ; one extremity for a length of 50 centimetres is cut into a cone.

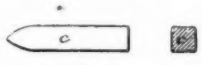


Fig. 1.

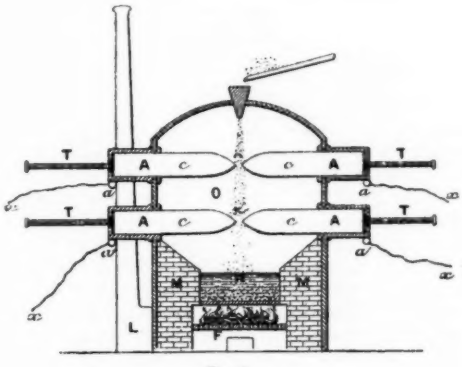


Fig. 2.

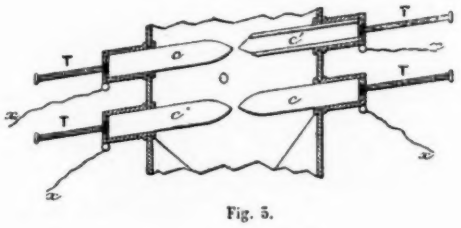


Fig. 3.

Fig. 4.

Such are the dimensions of our carbons, but they may be smaller or larger according to the purpose for which they are required.

We give the name of system to the set of two carbons placed in the same plane facing one another.

In our illustration (fig. 2) we see in the opening, O, two pairs of carbons, C, arranged one below the other ; below these two systems is the hearth, N, of a furnace, F, with a lateral chimney, L ; this furnace is intended to keep up the heat of the hearth in case of need ; if not, it is suppressed.

Above these carbons at the top of the furnace is a hollow metal cone. Above the cone is an inclined plane ; this inclined plane brings the ore prepared as already described, and conveys it into the cone. At the bottom of the cone is a hole somewhat larger than the extremity of the inclined plane down which the ore is conveyed. The bottom of the cone is situated just over the space between the two carbons in each system, so that the ore falling through the cone passes between them.

Thus, in our opening, O, we have two or more carbons, C, the bases of which are enclosed in a metallic armature, A. Each of these armatures is provided with a ring, *a*, intended to attach the conductor, *x*, of the electricity and a rod, T, with a screw and plug like a porte crayon, which pushes the carbon forward as it is consumed.

These arrangements being made, we have only to attach the electrical conductors, *x*, to the rings of the armatures of each carbon, and immediately the electric light is produced between the conical extremities of the carbons at Z. We have then only to send the ore through the metal cone at the top of the furnace. This ore passes through the electric light, Z, of each system ; is melted, and the melted metal and the earthy matter fall together into the hollow, N, where they are separated by their respective densities. Fig. 3, which shows a portion of the furnace (that portion containing the opening), represents another mode of arrangement of our systems of carbons. In fig. 2 these systems are placed horizontally ; here they are placed on an inclined plane. Moreover, the carbon, C', which we show separately in fig. 4, is hollow throughout its length ; this hollow is cylindrical, its base being 40 centimetres, and its height, which is identical with the length of the carbon, 3 metres. This carbon is constructed in this manner in order to convey through it the ore or metal to be melted, which is pushed forward to the electric light by means of the rod, T, as long as any remains in the cylinder ; when there is no more the rod is drawn back, and the hollow carbon cylinder is refilled.

We have said that in certain cases we use more than two systems ; sometimes we use six, and even nine. When we use six, arranged according to the second method, there are only two systems with a carbon similar to C' (fig. 4). In the case of nine, there are three of these carbons, and if we had to use 12 systems, there would only be four.

We do not think it necessary to enter here into details as to the generator of electricity, any more than if we were speaking of a machine worked by steam power we should describe the steam engine ; for as there are many forms of steam engines, so there are a thousand ways of producing electricity, such as batteries of all kinds, electrical machines, steam engines, magnets, electro-magnets, &c. ; we will only say that we adopt the most powerful source as being the most economical, this being produced by means of batteries, electro-magnets, and an hydraulic wheel or steam engine ; but this is not the object for which we are taking out a patent ; what we claim is the application of the light produced by means of electricity.

The drawings accompanying the above description are here reproduced.

We must admit that Pichon's furnace, with some slight modifications of construction and with an automatic method of pushing the carbons forward, might have been used for industrial purposes at the present day. It is, in fact, evident that it very strikingly resembles the electrical furnace described by C. A. Faure, in his French patent, No. 139,188, October 15th, 1880. In this patent is claimed : The industrial application of the heat produced by the arc, the discharge or conveyance by electricity of alkaline metals, either for their reduction or for the purpose of obtaining other chemical combinations of these metals.

Pichon, in 1853, had at his disposal the Nollet machines, which were known later on as the machines of the Alliance Company, and it is evident that Pichon speaks of the hydraulic wheel, and thinks it might be employed for working a magneto machine. He therefore foresaw what is now an accomplished fact, the utilisation of waterfalls for the production of electrical energy, and the reduction of ores by the calorific action of the current.—A. M. Tanner (*L'Industrie Electrique*).

THE SCIENTIFIC AMERICAN DYNAMO.

ACCORDING to a promise given several times in our Notes and Queries columns, says the *Scientific American*, we now present our readers with an illustrated description of a plain shunt-wound dynamo of simple construction, capable of supplying a current to from 60 to 75 110-volt incandescent lamps, or of being used as a 5-horse-power motor.

This machine was constructed especially for the benefit of the readers of the *Scientific American*, by Mr. W. S. Bishop, of New Haven, Conn. It was designed to meet the wants of mechanics and amateurs who desire to construct a simple dynamo or motor for their own use, but do not care to enter into the matter scientifically.

Now, although this course may enable many to make a fairly practical machine, while possibly a few may chance to build machines equal to those from the best makers, we recommend a thorough study of the principles involved in the construction and operation of dynamos and motors, before proceeding with the mechanical work. There are many good books on this subject, and there is now no excuse for ignorance in electrical matters.

The machine, as will be seen in the perspective view, is vertical, the polar extremities of the field magnet being uppermost, the journals of the armature being supported by arms thrown out from the sides of the field magnet.

The yoke is a single casting, which is planed on its upper surface to receive the squared ends of the arms of the field magnet; these arms being fastened to the yoke by tap bolts passing through the yoke into the ends of the arms.

The waists of the field magnet are slightly thicker at the middle than at the edges; this form being given to facilitate the winding. To the arms of the field magnets are fitted oblong spools of heavy paper or pasteboard, and to these spools is fitted a hardwood mandrel, which is able to resist the pressure of the wire wound upon the spools. The winding is done in a lathe, the mandrel being revolved slowly to admit of careful work.

The dimensions of the field magnet are tabulated below:

Total height of field magnet	$20\frac{5}{16}$ inches.
Width	12 "
Height of polar extremity above winding ...	$6\frac{1}{4}$ "
Height of waist	$9\frac{1}{2}$ "
Thickness at the centre	$4\frac{1}{2}$ "
Thickness of yoke	$4\frac{1}{2}$ "
Diameter of bore of polar extremities ...	$5\frac{1}{8}$ "
Diameter of armature, about	5 "
Length of arms for supporting the journal boxes of armature shaft, commutator end...	$9\frac{1}{2}$ "
Pulley end	$5\frac{1}{4}$ "

The principal dimensions of the armature are tabulated below:

Length of armature shaft	$36\frac{1}{2}$ inches
Largest diameter of shaft	$1\frac{3}{8}$ "
Diameter of portion enclosed in armature core	$1\frac{1}{4}$ "
Diameter of bearings	$1\frac{1}{32}$ "
Length of armature core	11 "
Diameter of armature core	$4\frac{1}{4}$ "
Diameter of pulley	6 "
Face of pulley	5 "
Length of journal boxes	$4\frac{5}{8}$ "

The details of the winding are given below:

The field magnet is wound with No. 18 Brown & Sharpe gauge single-covered magnet wire 12 layers deep, the inner ends of the two coils being connected with each other, the outer ends being connected with the commutator brushes. The armature is wound with No. 12 Brown & Sharpe gauge double-covered magnet wire, 32 coils, with eight convolutions in each coil. There are approximately 22 feet of wire in each coil. Weight of wire on armature 17 lbs., on field magnet 52 lbs. The machine, when run at 1,450 revolutions a minute, generates a current of 35 ampères, the electromotive force being 110 volts. When the machine is used as a motor, $1\frac{1}{2}$ ampères are consumed in the field magnet, and when the machine is running light only 1 ampère is consumed in the armature.

The armature core is built up of sheet iron discs $4\frac{1}{2}$ inches in diameter, with a central aperture $1\frac{1}{2}$ inches in diameter. These discs are separated by sheets of tissue paper, and clamped between end plates. They are insulated from the armature shaft by a vulcanised fibre tube $\frac{1}{16}$th of an inch thick. The end plates which clamp the soft iron discs, and also a central thick plate located at the mid-length of the armature core, have 32 radial slits in their peripheries for receiving the wedges which separate the different armature cores. One of the end plates rests against a shoulder on the armature shaft, and is prevented from turning by a key. The other end plate is also prevented from turning on the shaft by a key, and is pressed against the discs by a nut turned on the threaded portion of the shaft. The thick disc at the centre of armature core is prevented from turning by a pin driven in a hole drilled diagonally through the armature core, the central disc and the shaft.

The armature winding is done according to the system illustrated in figs. 2 and 3. In this case the winding of the first coil begins in space 1, is carried around through space 1*a* until the coil is complete. The armature is turned half way over, and beginning in space 2 for the second coil, the winding is carried around in the same manner, leaving the beginning and the ending of the coil in the same place and upon the same side of the armature. The armature is again reversed and the third coil is begun in space 3, leaving the intermediate space, 2*a*. When coil 3 is complete, the fourth coil is begun in space 4, on the opposite side of the armature, and carried through space 2*a*. The armature is again reversed, and the operation of winding is carried on in the same order, leaving a space between alternate coils upon one side of the armature. It is advisable to place mica between the different coils where they cross at opposite ends of the armature, to prevent the possibility of a cross or short circuit.

The commutator, which is of ordinary construction, has 32 bars, and is made according to the plan already given in the *Scientific American*, also in supplement 600. The terminals of the coils are connected with the commutator bars in the same manner as those of the Siemens machine several times described in these columns, that is to say, the beginning of one coil and the end of the preceding coil are connected to the same bar of the commutator. This order is preserved throughout.

The journal boxes of the armature shaft are supported between arms projecting from the sides of the field magnet. They consist of an outer brass shell and an inner bronze portion fitted to the journal box by means of a ball and socket joint, the inner portion being provided with a spherical central boss, which is babbitted in the cast iron outer part held by the arms. A ring of vulcanised fibre slipped over the commutator bars is provided in its outer edge with a groove in which is tied one end of the conical sleeve of canvas forming the covering of the armature, the sleeve at this time lying outwardly. The sleeve is then reversed and the free end is stretched over the terminals of the coils, and is secured to the armature by a binding of wire surrounding the canvas and clamping it tightly to the face of the armature. Six of these bands of wire are provided for confining the winding and preventing the armature being destroyed by centrifugal force. A slate plate on the top of the dynamo is provided with binding posts, which receive the wire supplying the current and also the wires connecting with the brushes, the safety fuses and also the shunt connections of the field magnet. The field magnet is furnished with ears at its ends, which are bored to receive rods inserted in castings designed for supporting the machine. In one of these castings is journaled one end of a screw, the other end of which enters a nut formed on the field magnet, the object being to provide means for shifting the dynamo or motor on its support to give proper tension to the belt running on its pulley.

A slate slab secured to the top of the field magnet serves as a cover for closing the gap between the polar extremities of the field magnet. To this slab are secured six binding posts, *a*, *a'*, *b*, *b'*, *c*, *c'*; the binding posts, *a*, *a'*, are connected with the brushes by means of flexible cords, the binding posts, *b*, *b'*, are connected with the posts, *a*, *a'*, by fusible wires, the binding posts, *c*, *c'*, are connected with the terminals of the field magnet. When the machine is used as a motor, the connections are arranged as shown in fig. 4. The leads, *d*, *d'*, through which the current is supplied, are connected with the wires, *e*, *e'*, through the double switch, A; they are also connected with the wires, *f*, *f'*. The wire, *e*, connects with one terminal of a rheostat, B, having a total resistance of 10 or 12 ohms. The other terminal of the

rheostat is connected with the binding post, b'. The wire, e', is connected with the binding post, b''. The wire, f, is connected with the binding post, c', and the wire, f', is connected with the binding post, c.

To start the motor, the switch arm of the rheostat, B, is placed on the point, which introduces its full resistance into the circuit of the armature. When the switch, A, is closed, the current remains constant in the field magnets independent of the current flowing through the armature.

Another portion of the current flows through the wires, e, e', the rheostat, B, the fusible wires and the binding posts, a, a', to the armature, so that in starting the motor a minimum of current passes through the armature. As soon as the armature acquires considerable velocity, the switch arm of the rheostat is moved gradually forward, the rheostat being finally cut out, so that the full current flows through the armature. The speed of the motor is then automatically regulated by counter-electromotive force.

When the machine is to be used as a dynamo, the connections are made as shown in fig. 5, that is to say, the leads, d, d', are connected with the binding posts, b, b'. Here the current divides. The rheostat, B, in this case is inserted in the circuit of the field magnet. The current generated in the armature passes through the binding posts, a, a', the fusible wires, and the binding posts, b, b', where it divides, a portion going through the leads, d, d', another portion passing through the field magnet, in which is inserted the rheostat, B. The current is controlled by introducing more or less resistance into the field magnet circuit by means of the rheostat.

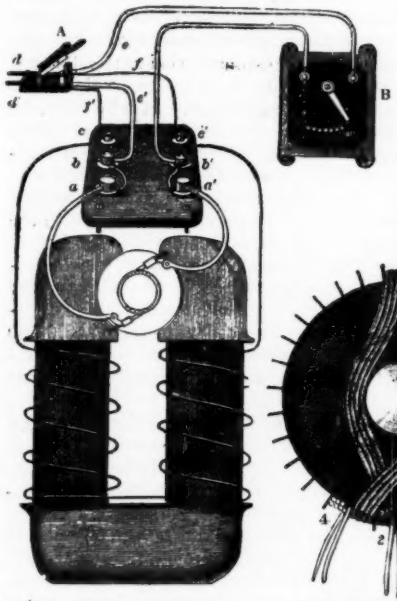


Fig. 4.—MOTOR CONNECTIONS.

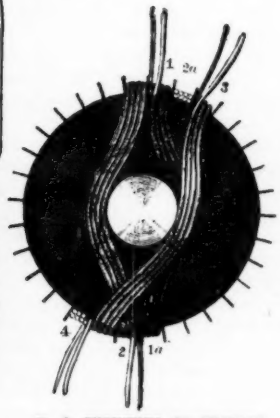


Fig. 2.—BEGINNING OF WINDING.

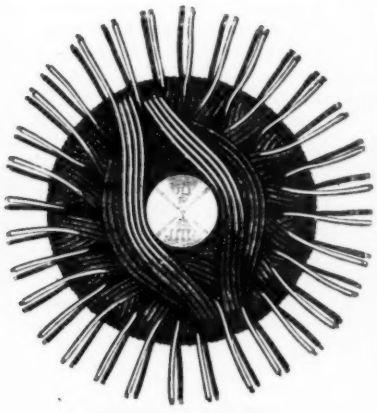


Fig. 3.—END OF WINDING.

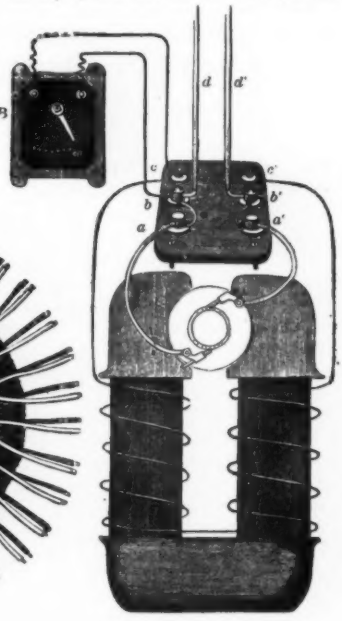
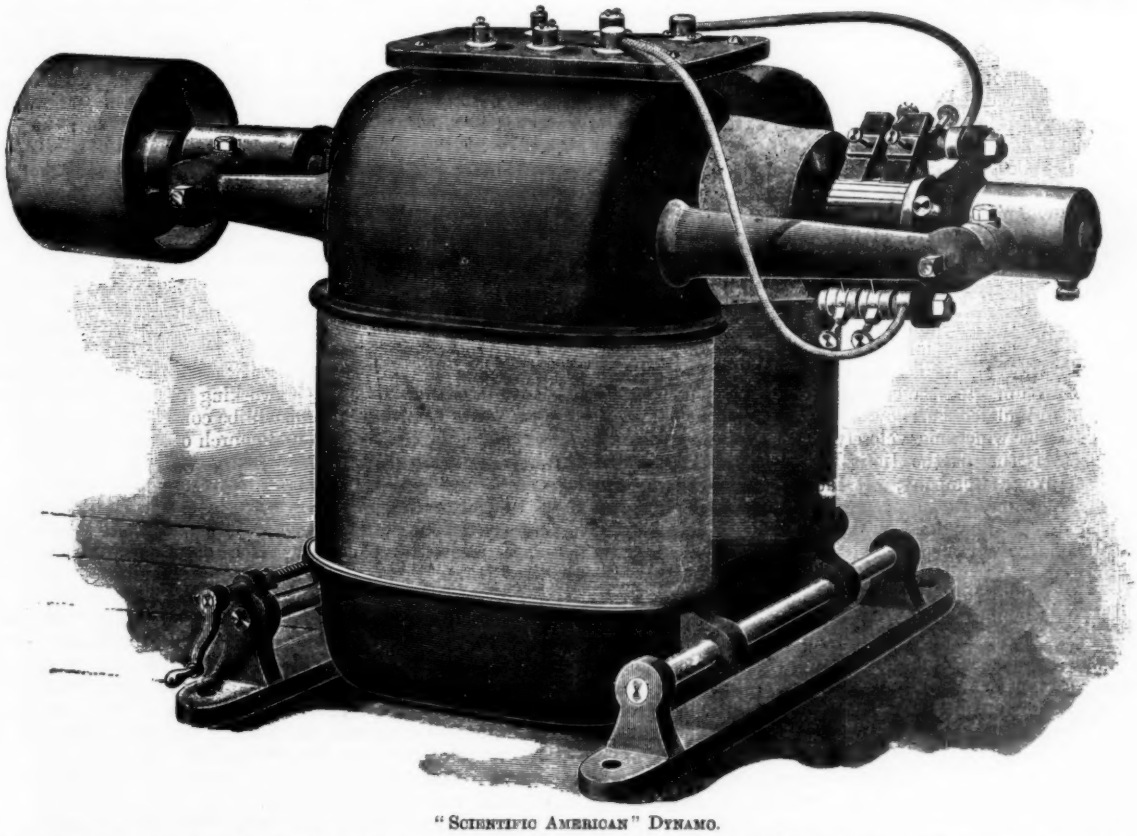


Fig. 5.—DYNAMO CONNECTIONS.



"SCIENTIFIC AMERICAN" DYNAMO.

In supplement 865 will be found an amplified description of the *Scientific American* dynamo and motor, together with detail scale drawings of their various parts, also a full description of the rheostat used in connection with the machine.

THE ELECTRIC LIGHTING OF BRUSSELS: THE AUTHORITIES' REPORT.

[FROM A CORRESPONDENT.]

THE Municipal Council of Brussels met on Monday last week to examine and discuss the question of the establishment of a service for the distribution of electricity. A report on the subject was published at the end of the previous week by M. Janssens in the name of the College, which will do much to enlighten the subject. The following is a short summary of the report in question:—The first part is devoted to an *exposé* of the question, and of the different phases through which it has passed in order to arrive at its present position: March 25th, 1889, approval of the conclusions of the Electricity Commission, tending to request tenders for the establishment and working of a distribution by electricity at Brussels, with a concession of 18 years, a minimum service of 10,000 lamps, and option of purchase by the authorities after three, six, or nine years, and after the expiration of the concession. On July 1st of the same year, was made the deposit of six tenders claiming a prolongation of the duration of the concession. Consequently, this period was lengthened to 25 years, and all the other conditions were drawn up in a specification, on which four new tenders were sent in on August 1st, 1890. But an examination of these tenders convinced the authorities that they were no more favourable to them than were the former ones, and the commission, without prejudging the final decision, and in order to defer to public opinion, studied the question of working by the authorities. A new specification was drawn up, and on October 30th last tenders were received from the following six firms:—1. Siemens & Halske, with the Allgemeine Elektricitäts Gesellschaft, of Berlin; 2. Schuckert, of Nuremburg, with Bouckaert & Co., of Brussels; 3. International Electricity Company, of Liége; 4. The India-Rubber, Gutta-Percha and Telegraph Works Company, of Silvertown; 5. Crompton and Co., of London; and 6, Ferranti, also of London. The report passes in review successively the propositions of these six firms, which have been the object of thorough examination on the part of two electrical engineers, in addition to the engineer attached to the communal technical service. This work, which was long and difficult, was finished on March 8th, and on April 15th the Electricity Commission unanimously supported the conclusions in the report of its engineers, formulated as follows:—

"The tender which most closely meets the announced requirements is that of the India-Rubber, Gutta-Percha and Telegraph Works Company. It satisfies all points concerning the steam engines and type of canalisation. The plan must, however, be modified by the intstallation of a battery of accumulators in the stead and in the place of the 125-horse-power engine; the engines and dynamos, from the third unit, should be direct coupling."

The India-Rubber, Gutta-Percha and Telegraph Works Company proposed a single station, delivering continuous current by engines of 500 horse-power, plus one of 125 for the day service; canalisation of the system known as drawing in cables insulated with India-rubber into metal tubes. When the finance section was consulted they unanimously supported, on the report of the technical service, the opinion of the College that the distribution of electricity should be made by the authorities. This resolution, it is said, was justified by the consideration that it was apparent from all the calculations and information supplied that it was possible for the authorities to carry on the working at a profit at least sufficient to make up for the loss which might arise in the sale of gas. It appeared, in short, from the report of the three engineers, that for a working of 10,000 lamps, with canalisation for 20,000, the net price, interest and amortisation expenses included, would not be more than 4¼ centimes the hectowatt-hour. A report from the technical service, dated April 16th last, supposes a working of 5,000 lamps only, but with an installation of 10,000 lamps, land and buildings for 20,000, canalisation for 9,100 lamps, extending to the middle of the quartier Léopold and the Avenue Louise, with metal canalisation to the extremities of those districts. Under these very unfavourable conditions, the net price rose to 6 centimes 7.

M. Janssens's report examines the figures given by similar installations in other large cities. Though the comparisons are, in general, more favourable for Brussels, where the net price will be considerably less, he estimates that at the start the net sale price of electricity will be little lower than that adopted in other places of the same size. It will leave, on the net price, a sufficient profit to cover the loss of profit from gas. This price would be 10 centimes the 100 watt-hours, with a reduction proportionate to the amount and duration of consumption. The small success of the electrical stations hitherto established in Brussels does not disturb the compiler of the report; they have met with the fate of undertakings whose output is too small to cover general expenses. Five thousand lamps, at least, are necessary in order to make an electrical station pay. The most modest estimates assure the authorities of Brussels a minimum of 6,500 lamps. In several cities, notably, at Berlin, the establishment of the electric light has done no injury to the gas interests.

Lastly, there is an interest for the authorities to remain masters of the undertaking, as much to avoid the difficulties of the concession giving to a third party the right to dig up the public thoroughfares, as to profit, and to make the inhabitants profit by the constant progress of electrical science and industry. These conditions have had the same influence in a large number of places, such as Cologne, Düsseldorff, Hanover, Hamburg, Breslau, Copenhagen, and Stockholm, which nearly all also retain charge of the gas. By the terms of the specification, the contractor must work the installation himself for two years. This is a serious guarantee, which is added to the others imposed in order to respond to all the exigencies of a good electrical installation. Consequently, in accord with the finance section, and with the electricity committee, the compiler of the report asks the council to vote the following resolutions:—(*a*) A service for the distribution of electricity, to be in the hands of the authorities, to be established. (*b*) For the construction of the station and the canalisation the College is empowered to treat with the India-rubber, Gutta Percha and Telegraph Works Company, according to the clauses and conditions of the specification. (*c*) The definitive plan of first installation shall be established in such a manner as not to exceed a total expense of 2,500,000 francs [£100,000], the necessary funds to be raised on loan. (*d*) The carrying out of this plan will be progressive, account being kept of the demands which arise, and, in the strictest measure possible, of the necessities, in order to render the working constantly remunerative. (*e*) The central station will be constructed on a portion of the land occupied by the old church of Sainte Catherine.

M. Bède opened the proceedings by saying he had sent his colleagues a proof of his speech. M. Richald wished to interrupt his colleague in order to ask for information as to a letter which had appeared in a Brussels newspaper, in which Messrs. Crompton & Co. complained that their estimate had been increased by 40 per cent. M. de Potter said that Mr. Crompton had called upon him and had complained of the concession going to the India-Rubber, Gutta-Percha and Telegraph Works Company. M. de Potter showed him that his figure was higher than that company's. Mr. Crompton told him he should take the matter into court, upon which M. de Potter rose from his seat and Mr. Crompton left. M. Janssen said this evinced a candidature manœuvre. The experts, watched over by Mr. Crompton, brought all the tenders to the same data, in order to establish the net price. The experts might be re-assured they would not go to prison. Messrs. Crompton's accusation was without foundation. M. Buls said that to the experts' figures those of Mr. Crompton had been added very fairly. M. Furnémont had never suspected either the experts or the engineers. Messrs. Crompton had asked him to plead for them against the authorities. M. Bède then delivered his speech, of which the following is a brief summary:—I consider myself as

charged with a special responsibility in the question which the council must solve. My special studies do not permit me to shelter that responsibility under that of the College, any more than under that of the Electricity Commission, even though my colleagues on that commission would give in their vote all the import which the College attributes to it. For myself, I have never believed that this vote signified that the Commission intended to reserve to one of the tenderers the execution of the installation of the lighting of Brussels, even according to a programme which was not submitted to it, and even when, on account of new information, it might be led to return on its vote in favour of that tenderer. The clearest conclusion to draw from the work I submit to my colleagues is the necessity for a serious inquiry, the object of which would be to obtain from administrations, or competent and disinterested persons, positive information permitting of discussing the truth in the midst of the contradictory assertions of the competitors, and not to risk throwing 2,500,000 francs into installations less perfect than those which would cost much less. We want but two months to make such an inquiry and communicate the results to the council. Now, these two months can cause no delay. It cannot be a question of finishing the installations before the winter, and they can be finished in six months. Therefore, if we have a conclusion before the end of October, we shall certainly be ready for the lighting season of next year. Among the plans presented, choice should, in my opinion, be restricted between that of the India-Rubber, Gutta-Percha and Telegraph Works Company, because it is supported by the College, by the engineers, and by the Electricity Commission's vote, and the Schuckert II. plan, because, while offering all the necessary guarantees, it was the lowest tender. The report showed that the installation for 10,000 lamps now, with a canalisation capable of later on receiving 20,000, would cost, on the Schuckert II. plan, 2,803,000 francs, and on that of the India-Rubber and Gutta-Percha Company, 3,762,000, the latter thus asking 959,000 francs more than Messrs. Bouckaert & Schuckert. One will understand my stopping before such a difference, while I set aside masters of lighting such as Messrs. Siemens and Halske, and the Allgemeine Elektricitäts Gesellschaft, because they ask 651,000 francs more than Messrs. Bouckaert and Schuckert. The difference, already very great, is, in reality, much larger. If one analysed the productive power of the mechanical and electrical installations of the two companies, it would be seen that that of the India-Rubber and Gutta-Percha Company could hardly feed 10,000 lamps, while that of the Schuckert II. plan could feed more than 13,000. He estimated that it was not the relative value of the competitors which could sway the administration to the side of the India-Rubber and Gutta-Percha Company, and he did not believe that that company could make economies in working expenses. He criticised the figures furnished by those who drew up the report, and reproached them with not having taken the particulars in the tenders sufficiently into account. He did not understand those who prepared the report reproaching the Schuckert firm with using accumulators on a large scale. M. Bède, on the other hand, saw in that system a guarantee of the regularity of the light, of safety, of duration of the lamps, and, further, economy; accumulators forced themselves upon Brussels on account of the configuration of the city. I cannot sufficiently repeat, continued M. Bède, accumulators are the great regulators of electrical stations. They allow of intermittent work being replaced by continuous work. They had not to light at certain hours a number of boiler furnaces which had to be extinguished a few hours later, to have a staff working during those few hours, to let it lounge about afterwards. They worked in open day, and thus important economies in fuel were realised, large supplies of electric current being at the same time obtained. As regarded canalisation, M. Bède recalled the fact that vulcanised India-rubber, furnished in 1887 by the India-Rubber and Gutta-Percha Company for the cable running from the gasworks to the Monnaie Theatre had cost a good deal for repairs. Mr. Preece had pointed out the confusion which might be caused by the danger points which were produced at the junctions. Contrary to the opinion of the College, M. Bède was a partisan of armoured cables laid directly in the soil; while also, contrary to the opinion of the College, he affirmed that the canalisation was not the most important point of an electrical installation. In conclusion, M. Bède said: Why should they renounce an enquiry, the asking of municipalities and the big lighting companies what results they had obtained from different systems? He asked that any question as to the electric lighting should be adjourned till October; in the interim competent men might be consulted. M. Depaire proposed to examine, in the first place, if the electric light would be established in the form of *régie* or of concession; that was the first question to elucidate. M. Hergvaert said that formerly the council had pronounced for the concession (March, 1889). After a discussion as to concession or *régie*, the latter being eventually adopted, M. Bède said that in 1889 a temporary concession only was foreseen, and a prompt taking over by the authorities. M. Janssen said that M. Bède wished to gain time—he, who for four years had demanded that they should go on. To-day, he bitterly opposes the system he voted for on April 15th last. To-day, he opposes the plan of the India-Rubber and Gutta-Percha Company, which on June 27th he declared to be good. M. Bède: I say so still. M. Janssen: And you oppose it! The experts' report has been attacked by a single person. M. Bède: But I have the right to say it emanates from competent and honest men. Why still adjourn? Are you waiting for another decision from new experts? Any adjournment would be very prejudicial to the taxpayers. In the end, the discussion was adjourned.

NOTES.

Memorial to Sir G. Gurney.—A painted window in memory of the late Sir Goldsworthy Gurney, C.E., was unveiled last Thursday week by the Duke of Wellington, at St. Margaret's Church, Westminster, in the presence of the Speaker, General Goldsworthy, M.P., the Rev. F. T. Batchelor, the Rev. H. P. Gurney (nephew of the deceased), and others. The window, says the *Daily News*, is the gift of Miss Anna Gurney, the daughter of Sir G. Gurney, but she was unfortunately unable to attend through illness. Archdeacon Farrar said that Sir G. Gurney was born in 1793. He was educated at Truro Grammar School, and there became acquainted with Humphrey Davy, and both of them studied chemistry with such apparatus as could be provided. At the age of 17 Gurney became a surgeon, but after practising for some years, he abandoned his profession, and devoted himself to scientific researches. In 1823, having meanwhile removed to London, he invented the oxy-hydrogen blow-pipe, and, by means of that appliance, discovered the limelight. Before this invention, the risk of explosion was so great that resource was very seldom had to oxy-hydrogen. The jet used in his experiments and studies upon this subject led to the invention of the steam jet, and Gurney was presented with the gold medal of the Society of Arts for the invention of the blow-pipe. He succeeded in constructing a steam carriage to travel on common roads, and in July, 1829, made his memorable journey with it from London to Bath and back again at the rate of 15 miles an hour. On another occasion the great Duke of Wellington rode in one of his carriages from Hounslow to London. After a time the running of steam carriages upon ordinary roads was thought dangerous, and it was put a stop to by the passing of Acts of Parliament imposing prohibitory tolls which were raised from pence to guineas. This ruined the undertaking as a commercial undertaking, and ultimately railways were introduced. Amongst the other inventions of Sir G. Gurney was the Bude light, for lighthouses, &c. For several years he lighted and ventilated the House of Commons, receiving public recognition for his services, and he also suggested the use of flashing lights for signalling at sea. It was claimed that the invention of the electric telegraph was really due to Gurney, who discovered that the magnetic needle placed in proximity to a conductor through which an electric current was passing would instantly place itself at right angles to that current. He called the attention of Prof. Wheatstone—who finally carried out the invention of the electric telegraph—to this discovery. Sir G. Gurney shortly after this was seized with paralysis, and died in 1880. For some time the deceased resided in Great George Street, Westminster. The memorial window, designed by Sir E. Frampton, is one of considerable beauty.

The Inception of the Commercial Cable Company.—According to the *Financial Times* correspondent, a very important suit was commenced in the New York Supreme Court on the 16th ult., in which Mr. James Gordon-Bennett was the defendant. The action was brought by Count Dillon, who claimed $2,000,000 as his share in the profits of the Commercial Cable Company. The plaintiff contended that Mr. Bennett promised him that amount in return for his giving up his personal stock in the cable so that a company might be formed. The Count conceived the idea of the Commercial Cable in the first instance, and was in partnership with Mr. J. W. Mackay in the original venture.

Durban and Electric Lighting.—The Durban Town Council recently discussed the matter of lighting the borough by electricity, and they have accepted the tenders of the Electrical and General Engineering Syndicate of Johannesburg, who propose to use the Thomson-Houston machinery (from the plans, specifications, and estimates of Mr. F. H. Hadfield, A.I.E.E.). The tender was considered a satisfactory one, and the borough will be lighted in the course of nine months by electricity. The public lights to be used will be 40 arc lamps of 1,200 candle-power each, and 400 incandescent lamps, each 25 candle-power. This light will be supplied for £2,000 per annum, and consumers will benefit equally with the tenderers, after a reasonable profit has been set aside. The cost of the private lighting will be at the rate of 1s. per Board of Trade unit.

A New Mercury Elevator.—Makers of incandescent lamps, vacuum tubes, &c., and others who constantly use Sprengel's mercury pumps and the various modifications of it which are extant, must have found by experience how desirable it would be if the mercury which falls in working the pump could be returned at once to the cistern at the top of the instrument without requiring any personal attention, so that the process of exhaustion might go on without interruption. Such will be interested in a device which Mr. F. J. Smith, M.A., the Millard Lecturer on Mechanics and Physics, Trinity College, Oxford, describes in the July number of the *Philosophical Magazine*. This device, when added to the ordinary mercurial pump, renders it self-acting. It is designed to replace the water engine which was described in the *Phil. Mag.*, xxv., p. 313, whereby mercury was raised for driving a pump used for exhausting glow lamps. This arrangement was satisfactory, but costly, and required careful adjustment. The mercury elevator produces the same results, is automatic, and is by no means expensive. It is nothing more than an inverted Sprengel pump, worked backwards. When a vacuum is formed under ordinary circumstances, air is forced in, and instead of little cylinders of mercury falling, they are raised.

The Volume Effects of Magnetisation.—The volume effects which magnetisation produces upon various metals have long been known to present several anomalies; thus bars of soft iron or cobalt become longer and more slender, whilst bars of nickel or steel become appreciably thicker and shorter. This curious subject has not been much explored, but the recent researches of Prof. Knott and Mr. Shand promise to add a great deal to our information concerning the changes in apparent volume produced by magnetisation. Some results have already been communicated by these gentlemen to the Royal Society of Edinburgh, and at the meeting held on June 20th a paper containing some further information was read. The experiments were performed with iron tubes of various bores, but of similar outside dimensions and of the same material. In magnetic fields of low strength the tubes possessing the thinnest walls experienced the greatest dilations of internal volume, but in the case of the tubes with the thicker walls the greatest internal dilation was manifested when they were exposed to the forces acting in strong magnetic fields. The tubes experimented with varied in their internal diameters from 16·0 mm. to 3·5 mm., and their dilations in a field of 1,400 beginning with the one of widest bore varied from $+ 4 \times 10^{-7}$ to $- 129 \times 10^{-7}$. The extreme limit of dilatation was reached with the wide-bore tube when placed in the 1,400 field, and the iron was practically saturated.

The Electromotive Activity of the Ions.—A comparison has recently been instituted by W. Nernst and R. Pauli with regard to the results which have been obtained by theory and by observation concerning the electromotive activity of the ions. The observed results were obtained by considering the electromotive forces developed in "liquid cells," made by the combination of deci-normal and centi-normal solutions of potassium and hydrogen chlorides; these were compared with the numbers deduced from the osmotic pressure and dissociation hypothesis. The general agreement between observation and theory was considered satisfactory. The following example from their paper seems to show that we must not seek for the seat of the E.M.F. in a Daniell element at the contact of the two liquids. As solutions of zinc sulphate and of copper sulphate having equal molecular concentrations, are very nearly equally dissociated into ions, it follows from the theory that there should be no considerable electromotive force at their surface of contact. By investigating the combination

$$Hg \mid Hg\,SO_4 \mid \tfrac{1}{10}\,n\,Cu\,SO_4 \mid \tfrac{1}{10}\,n\,Zn\,SO_4 \mid Hg\,SO_4 \mid Hg$$

Nernst and Pauli found that in reality the E.M.F. is only 0·00024 volt.

The Aurora Borealis.—At Godthaab, in South Greenland, auroræ boreales are, of course, frequently observed phenomena, and from a lengthy series of observations which have been made on them there and elsewhere, A. W. Paulson has recently come to certain important conclusions. In temperate countries the auroræ take place in the higher regions of the air, whilst in the south of Greenland, the region in which they are produced, probably extends from high altitudes to the surface of the ground. Hypothecating, therefore, the electrical origin of the phenomena, it appears that an electric current circulates in low latitudes in the higher regions of the atmosphere, whilst in the zone proper of auroræ boreales, it descends to the surface. Doubtless, too, they are connected with the rarefaction of the air: a great difference in this property being observed in the atmosphere of arctic and temperate regions. At Godthaab, the greatest daily activity of the auroræ is at 9 p.m., and the annual maximum is about the winter solstice; there is a maximum frequency at those periods when the number of sunspots is *smallest* and conversely. The observations which have been made appear to contradict Trombolt's law, according to which the auroral zone moves in the course of 24 hours, so that it is directed to the north.

Researches on the Glow Discharge.—An investigation into the character of the glow discharge has recently been conducted by Herr E. Warburg, and the results obtained may be briefly summarised as follows:—By means of the balance the electrostatic attraction which a plane cathode surface experiences in the glow discharge may be measured, and from this determination both the electrical force and the surface density on this surface may be calculated. The attraction is proportional to the direction of the current. In the negative glow light there is an excess of free positive electricity, which is opposite and equal in amount to the negative charge of the cathode. It is proportional to the square root of the density of the current. The surface of the anode is much more feebly attracted, and consequently is much more fully charged than the surface of the cathode. If, therefore, two infinitely large parallel electrode surfaces are opposed to each other, they are strongly charged only so long as the electricity is in equilibrium, but if the glow discharge passes between the surfaces, the charge of the anode is fuller than the charge of the cathode by the excess of free positive electricity, which is present in the gas through which the current passes. The electrical force at the cathode decreases with decrease of pressure at the normal density at which the negative glow light can spread freely over the cathode. It is also less for hydrogen than for nitrogen in accordance with the laws of the striking distance. Hence at normal density the excess of free positive electricity in the gas decreases with decrease of pressure. The material electrical charge of the gas which takes place in the glow discharge brings with it an increase of the hydrostatic pressure, and therefore under ordinary circumstances produces eddy currents which flow between limited electrodes from the anode to the cathode, and may account for the so frequently observed transfer of matter in the direction of the positive current.

Utilisation of Water Power in Switzerland.—A plant has been recently erected to utilise the falls of the Valoirette, a tributory of the river Arc, near Mont Cenis. Near the confluence of the two streams a canal, 2,625 feet long 6½ feet wide, and 3¾ feet deep, has been constructed to the reservoir. The canal has a fall of 0·22 per cent., and passes 106 cubic feet of water per second. The entire hydraulic plant is capable of supplying 6,000 H.P., but at present only one establishment—an aluminium factory—has been connected with the reservoir. Connection is made by a 24-inch pipe line sufficient to generate 1,000 H.P. One turbine is connected to a dynamo running at 135 revolutions, and giving an output of 4,000 ampères at 500 volts.

The Electric Light in Italy.—A proposal has been made to erect a large central station to generate the current necessary to light by electricity the public streets of Velletri, which are now illuminated by means of petroleum.

Electric Work in Japan.—A recent official report draws attention to the fact that, with certain exceptions, contracts for electrical and other works required by the Japanese Government are now put up to public tender. The conditions of tender are advertised, and a deposit is required of each person tendering. A deposit—generally 10 per cent. of the contract amount—is further required of the successful tenderer when he takes the contract. It is also necessary that proof shall be produced that the maker with whom the contract is placed is in the habit of manufacturing the class of goods tendered for.

Chelmsford Electric Lighting.—The Lighting Committee of the Chelmsford Town Council reported that Messrs. Crompton & Co. had written stating that a joint stock company, called the Chelmsford Electric Lighting Company, had been formed, and that they proposed to transfer the lighting of the town to them. The committee recommended that this course be agreed to, provided that two independent sureties be submitted by Messrs. Crompton for the due performance of the remainder of the contract. The committee also reported that they had returned to Messrs. Crompton their account for lighting the town, and had informed them that complaints were frequently being made of the unsatisfactory working of the arc lamps, and asking what reduction they proposed to make? Messrs. Crompton had replied that they were unable to make any reduction, but they proposed shortly to replace the existing lamps with new ones, which they hoped would remedy the defects. In these circumstances the committee recommended that the account be paid. After a short discussion the town clerk read another letter from Messrs. Crompton in which they stated that the new company had been incorporated to meet the requirements of the Board of Trade that the town lighting accounts should be separately kept. Eventually the report was adopted, on the understanding that Messrs. Crompton and two independent sureties become guarantors for the due performance of the contract.

Electric Tramcar Accident.—An action was brought against the Southend Local Board at the Essex Assizes on Saturday last, before Mr. Justice Hawkins, for damages for personal injuries sustained in an accident on the electric tramcar on Southend Pier by the alleged negligence of the board's servants. The plaintiffs were Mr. Arthur Walker Jones, City traveller to Messrs. Mordan & Co., gold pen manufacturers, of City Road, and his daughter, Edith F. Jones. The evidence showed that in June of last year the plaintiffs were passengers on the electric tramcar, which, on arriving at the end of the pier, came violently into collision with the buffers. Mr. Jones was thrown on to the seat in front of him, sustaining an injury to the knee and general shock to the system, while his daughter was thrown against the front of the car, and her jaw was injured. In consequence of the accident Mr. Jones had been unable to attend to his duties as heretofore, and his earnings had been reduced by £45 a year, while his daughter had been in a very nervous state ever since. The defendants had paid £50 into court, in satisfaction of Mr. Jones's claim, but the jury awarded him £150. In the case of the daughter, £5 had been paid into court, and the jury held that this was sufficient.

Elmore Foreign and Colonial Company.—A letter appeared in last Friday's *Financial News* from one of the unfortunate shareholders in the Elmore Foreign Copper Company, who signs his complaints and criticisms "Hope deferred," which seems a most significant and applicable name for the holders of Elmore shares. In the course of his remarks he speaks of feeling very disappointed and irritated at the manner in which the priority shareholders are being treated. "Nearly two years ago," says he, "I purchased some priority shares at a premium of 100 per cent., expecting that the proceeds from sales of patents would be exclusively, or, at any rate, primarily, devoted to paying off the £10 per share (less income-tax) promised thereon, with the prospect of subsequently sharing in further profits. So far, only £5 (less income-tax) has been paid, although the American and Canadian patents, in addition to the French and German, have been disposed of, producing, I presume, more than enough to pay off the £10 in full. Instead of this, apparently, funds are being expended, chiefly in financing the French company, while we are being deprived of our share of profits, to which, in my humble opinion, we are justly entitled. Some six months ago I was informed by the secretary that the American patent would probably be disposed of in a fortnight, and the proceeds 'will be devoted' to paying a dividend on priority shares as soon as the same were available. Has this course been adopted? Undoubtedly, the greatly depreciated market value of the priority shares at present is due to the policy pursued by the directors. A general meeting should, in justice to all, be promptly convened, and the situation explained, and a balance-sheet submitted for the information of those concerned."

Electric Lighting in Newcastle.—A meeting of Newcastle Watch and Town Improvement Sub-Committees was held last week, when it was agreed to allow two electric lights to be placed next the Monument—one to face Grainger Street and the other Blackett Street, and also one near the Green Market.

Electric Lighting at Larne.—On Tuesday last week a very satisfactory trial run of the electric light was made at Larne by Messrs. J. E. H. Gordon & Co., who are the electrical contractors. It is stated that a formal inspection is to be made by the commissioners almost immediately.

Heckmondwike Electric Lighting.—The Electric Lighting Committee of the Heckmondwike Local Board have modified their recommendation "to put down the necessary plant for lighting the town by electricity, as per a report previously submitted to the board," to read, "That the board be recommended to consider the propriety of," &c.; and Mr. S. Wood, the chairman of that committee, gave notice that at the next meeting of the board he would move a resolution authorising the construction of the needful plant for lighting the town with electricity.

Taunton and the Electric Light.—A special meeting of Taunton Town Council was held last week. The Watch, Lighting, and General Purposes Committee's report recommending positions for seven new electric light lamps in Staplegrove Road, The Crescent, East Beach, and Silver Street, was adopted with three dissentients. The committee recommended that the amount necessary for the purchase of the electric light works, plant, machinery, and undertaking for obtaining the license and the costs attendant thereon, and for the improvement and extension of the works, machinery, and wires should be raised by borrowing the same under the powers and provisions of the Taunton Corporation Act, 1889, and that the same should be repaid during a period of 50 years, or such other period as the Local Government Board would grant for the purpose. The estimate amounted to £14,000, and this amount included £9,300 for the purchase of the works, £1,290 for substitution of underground for overhead wires by the Fowler-Waring system, and £1,000 as working capital. The report was adopted after considerable discussion.

Skin Resistance.—In commenting upon the evidence given by Mr. Gatehouse in a recent trial in which an "Electropathic belt" formed the bone of contention, *Science Siftings* says: "We should suppose, as a matter of fact, that an infinitesimal current must have actually passed *through* Mr. Gatehouse's leg or arm." We fail to see the grounds for such a supposition. It is known that the interior of the body, with its blood vessels, muscles, tissues, &c., has a very low resistance, and it is also equally well understood that the measured high resistances between any two parts of the frame is due to the skin alone; therefore, if our contemporary had said *over* or *across* instead of *through* the arm or leg, we should not have deemed it necessary to find fault with its science.

The Electric Lighting of Nelson Borough.—The Nelson Corporation have received a communication from the Local Government Board with regard to the proposal to borrow £10,000 for the purpose of electric lighting. The Local Government Board sanction the borrowing of £4,000, and state that they will be prepared to deal with an application for increased expenditure upon an extension of the scheme when the necessity for such extension arises. The electric lighting scheme, which has been approved by the Town Council, provides for an installation for the central parts of the town.

International Exhibitors' Association.—A combination of New York merchants has been formed for co-operative work in connection with the Chicago Exhibition, with a view of reducing the expenses connected with getting goods to Chicago from the time they arrive in the port of New York until delivery in the exhibition grounds, installing them and looking after them during the time of the show, all of which the association undertakes to do at a minimum rate. Intending exhibitors might find it to their interest to communicate with the secretary, Mr. T. A. Matthews, Room 183, Stewart Building, New York. The time allowed for installation of exhibits is from November 1st to April 1st.

Cyrus Field's Will.—Dalziel's New York correspondent cables that the will of the late Cyrus W. Field was filed for probate on Tuesday. The estate is estimated to be worth $350,000, including life assurance policies amounting to $300,000. The property is divided in five equal parts among the children of the deceased.

Electricity on the North Metropolitan Tramways.—At the half-yearly meeting of the North Metropolitan Tramways Company on Wednesday last, the chairman, after moving the adoption of the report and balance-sheet, said the directors had worked electric cars for some time on the Barking Road, but the experiment had not turned out as they could have desired, in consequence of which they had been compelled to withdraw the cars, and return to their old arrangements. The chairman added that the directors had entered into a contract with a firm of electricians, whereby the latter at first supplied motive power on the terms of 6¼d. per car per mile, which, at the electrician's request, was subsequently increased to 6½d. per car mile. On the other hand, the cost was only 5d. to 5½d. per car mile when they used horses, and the company did not feel justified in throwing away the extra penny a mile, nor, in their opinion, was it at all necessary. Here is another chance for Mr. Epstein.

Proposed Electric Light for Michelstown. — Mr. Abraham Sutton, of Cork, has written to a number of the leading inhabitants of Michelstown, enquiring whether the townspeople would entertain a reasonable proposal from him to light the town with electricity. Mr. Sutton states that he has a powerful engine at his stores at the Michelstown Railway terminus which, in addition to doing his own work, would be able to generate sufficient electricity for the above-mentioned purpose. Mr. Sutton's proposal is received with much favour.

Coast Communication.—In commencement of the system of establishing telegraphic and telephonic communication around the British coast the telegraph steamer Monarch, with Lieut. Williams, R.N., and Mr. Lumsden, the electrician, on board, arrived at Scilly on Tuesday afternoon, and on Wednesday last commenced the work of connecting the coastguard stations at St. Mary's, St. Agnes, Bryher, Tresco, and St. Martin's. Before darkness set in on Wednesday night they had laid a cable from Bryher to Tresco, and from the Cove, at St. Agnes to about half way to Porthcressa Beach at St. Mary's, where they buoyed the end of the cable for the night. This communication will be of the greatest value for conveying news of wrecks to the lifeboat stations at night during the prevalence of fogs.

Training would-be Electrical Engineers.—According to the *Engineering Magazine* (New York), the question as to the best course of study to be pursued by young men seeking to gain a thorough knowledge of electrical engineering received considerable attention at the late annual meeting of the American Institute of Electrical Engineers. Most of the leading technical colleges were represented by their professors of electrical engineering and physics, and the proceedings, which were quite animated, served to contribute much valuable information on this important subject. In a paper read at this meeting Prof. Owens pointed out that at the present day there were really three distinct classes of electrical engineers—installing engineers, who superintend the construction and operation of lighting and power plants; designing engineers, whose province relates to the construction or manufacture of machinery and apparatus, and a third class who are engaged more particularly in laboratory, standardising and experimental work. He thought that the course in any technical school ought to recognise these distinctions, and that it should be so shaped as to conform to the different requirements of the specialised divisions of electrical engineering. While it is neither desirable nor possible that the courses in the different schools should be alike, it is obvious that much waste of effort might be avoided if the different institutions would observe a certain unity of purpose and treatment. All were agreed that the importance of mechanical drawing and of manual training as factors in elementary education could not be over-estimated. "The practical engineer," said Prof. Jackson, "must be pre-eminently an enthusiast, while he is at the same time a candid and careful thinker."

Electric Traction in New York.—The Second Avenue Street Railway Company, of New York, has applied for permission to use storage batteries for electric motor power.

School Electric Lighting.—The Staffordshire County Council have decided to light the County Industrial School at Werrington, near Crewe, by electric light, instead of paraffin as at present.

Dublin Electric Light.—Last week several of the electric lamps were lit for the first time, with the object of testing their efficiency. About 12.30 a.m. on Tuesday several streets were brilliantly illuminated. The light burned steadily and clearly.

The Crystal Palace Exhibition.—Messrs. Pyke and Harris write to us in the following significant terms:—"We notice that several firms who showed splendid general exhibits at the recent Crystal Palace exhibition that must have benefited trade as much as they interested the general public, if one may judge by their advertisements, appear to consider that the award was chiefly obtained by reason of the excellence of their storage batteries, and not by reason of their dynamo machines, electric frying-pans, &c. We should be glad to know if we are mistaken in supposing that their storage-batteries were not even tested competitively with those of other firms to whom awards for this special type of apparatus were given."

The Resistance of the Human Body.—Among the papers before the British Association, we see there is one by Mr. H. Newman Lawrence, upon the body as a conductor, and we understand that the author intends making application thereon for a Government grant to assist him in settling the vexed question of the resistance of the body under various conditions. Reliable and definite information on this point would be of great importance in connection with "electrical accidents," as well as valuable to electro-therapeutists. Mr. Lawrence's researches have already thrown considerable light on the effect upon the body of electric currents, and we venture to think that any grant the British Association may vote him for further investigations would be well invested.

Correction.—In the annual report of the International Electric Company of Vienna appearing in our issue of 22nd ult., the name of the village where the electrically-lighted palace "Achilleon" of the Empress of Austria is situated, should read "Gasturi" (near Corfou), not Gastein.

Electropathic Belts.—We reproduce the following remarks from the columns of our contemporary, *Industries*:—"One of the greatest impostures of the day received a severe blow recently. A patient suffering from hernia had applied to the Medical Battery Company. He was examined by an expert, whose qualification consisted in his being a salesman in the West End. This exceptionally qualified medical man told the patient he was not suffering from hernia, but might do so soon if he did not wear one of Harness's notorious so-called electric belts. This was therefore applied. It gave rise to great pain, and the patient eventually consulted a doctor, who told him he had been suffering from hernia all the time, and that the so-called electric belt was injuring him seriously. The patient had only paid £2 out of £5 5s. for the belt, and was sued by the so-called Medical Battery Company, with the result that he obtained his money back. Let us consider this exposure of astounding quackery. A man believes he has a very serious complaint. He sees electrical cures advertised in all directions, and seeks medical advice. He is introduced to a shopwalker, who poses as a qualified medical man, and foists upon the patient an absurd belt with bits of zinc and copper sewn in, and charges five guineas for it. It must be remembered that this is not an isolated case. The salesman from the West End stated that he had "treated" some 16,000 cases. That is to say, the health, and perhaps the lives of 16,000 people have been wantonly risked, and something like £80,000 taken as payment. Our readers may think it strange that a technical journal should devote space to a case about electropathic quackery. Unfortunately, there is little chance of such cases being known otherwise, as the daily papers have taken their share of the £80,000, and are not, therefore, prone to explode this scandalous fraud. We are glad to see that Mr. Gatehouse gave evidence as to the uselessness of the belt. Mr. Gatehouse has, perhaps, done more than any other person towards exposing this system."

Dublin and Electric Lighting.—At the suggestion of Captain Purcell the Dublin Corporation Electric Light Committee have agreed to instruct the contractor for work in connection with the lighting of civic buildings at the Central Station, Clarendon Row, to erect a special circuit with 15 lights, controlled by a single switch of special design in connection with the present electric alarm, so that should notice of fire be received through the night, the movement of switching on the general alarm would turn on the lights in sufficient quantity where required.

Electrocution.—A *Daily News* telegram from New York states that Joseph Wood was executed by electricity on Tuesday last, in Dannemora Prison, for the murder of his father-in-law. Death is reported to have been painless and instantaneous.

Promotion for the Superintendent of the Leeds Telegraph Department.—Mr. E. Trenam, the superintendent of the department of telegraphy at the Leeds post office, has just been offered and has accepted the position of superintendent of the telegraphic branch of the Manchester postal service.

London Electric Supply Corporation.—We understand that at the Deptford station lamps are being put on at the rate of about 200 per week, 12,000 having been added during the past year. It is stated that everything has been running satisfactorily at the station, without any mishap. The company announces that the charge for current will in future be 7d. per Board of Trade unit.

On Delicate Ground.—Under the caption, "Electric Belt Quacks Exposed," *Science Siftings*, dated August 6th, devotes a long article to the consideration of the recent trial of the Medical Battery Company *v.* Jeffery. Our contemporary believes its censures to be part of its duty to the public; and the writer, first of all, falls foul of the newspapers, suggesting that they have a tacit understanding with advertising charlatans, which leads them to repress anything likely to reflect upon the "shady or very questionable" business done by these impostors. But why, we ask, does our contemporary allow such an advertisement on its title page of the same issue as "Count Mattei's Electro-Homœopathic Medicines?" Are these more efficacious, or less shady, than the appliances which called forth our contemporary's ire? Truly, in these days, science is not the only matter which requires sifting.

BRITISH ASSOCIATION, 1892.

THE British Association meetings hitherto held in Edinburgh have been remarkable for the high level of scientific work, and the large support of local people. Considering, perhaps, the great reputation of Edinburgh as a centre of culture, it could not well be otherwise.

The opening on Monday of the Reception Room in the old Parliament House, was marked by a big crowd anxious to register their names, and particularly to secure tickets for excursions, and it was perhaps remarkable that many of these tickets were asked for with a decided Scottish accent.

Although the real business of the Association did not begin until Wednesday evening, over 1,000 members had been registered on Monday night, which number is within 400 of the total enrolled at Cardiff last year.

The "distinguished foreigner" is to take a prominent part both in the reading of original papers and discussions. Among those expected are Drs. Helmholtz and Lindeck, Arrhenius, Van't Hoff, Prof. C. B. Peterson, of Indiana.

The success of a B.A. meeting is, no doubt, due in a great measure to the ability of the local committee. Judging from the arrangements already made for the comfort of visitors, there is every indication that one of the most successful of latter-day meetings will result.

It might have been expected that with so eminent a geologist as Sir Archibald Geikie as president, the meeting would have resolved itself into a geological one pure and simple. "Such, however, is not the case," for besides capital papers on various subjects, there are many indications of good electrical papers. Although it may be premature to say so, there seems a possibility that Section A will contribute more to electrical science than Section G. A glance at a preliminary list shows that a greater activity is likely to prevail in Section A, as regards electrical subjects, than has prevailed for years; yet it is curious to note that most of the sectional officers are not so strongly identified with electricity as the others of former meetings.

That which should result in real and lasting good is a discussion on electrical units in Section A, in which Helmholtz and Lindeck are expected to take part. It will be no doubt remembered that a long discussion took place at Cardiff last year, and although the speakers were by no means unanimous in their opinions, the ventilation of the subject resulted in some good. No doubt definite conclusions will be arrived at this year. Then there is to be a discussion on a National Physical Laboratory to be opened by Dr. Oliver Lodge, which will be a continuation of the subject from last year. Among the papers to be read in this section, it is expected that one by Prof. Ewing, "On a Magnetic Curve Tracer," will be of great importance. Dr. Lodge

reads one "On the Influence of Magnetisation on the Velocity of Light." Prof. Schuster, the president of the Section, on "Primary and Secondary Cells, in which the Electrolyte is a Gas." Mr. Du Bois reads two papers on "Leaky Magnetic Circuits," and on "A Magnetic Balance and its Practical Use." Prof. Ayrton, in conjunction with Dr. Sumpner and Mr. E. W. Smith, reads papers on "Transformers," Prof. Knott on "The Volume Effects of Magnetisation," Mr. J. Gray "A Contribution to the Theory of Perfect Influence Machines," and Mr. Preece may read a paper on "Inductance." Messrs. Barton and Williams are down for "The Temperature Variation of the Magnetic Permeability of Magnetite," and Dr. Dawson Turner will read a paper on "The Modifications of Electrical Resistance Produced by Neighbouring Discharges."

Prof. Unwin presides over Section G, and it is probable that his presidential address will treat among other things of the utilisation of water power. Mr. A. R. Bennett will, no doubt, add a sequel to his famous paper on "Telephony" read at last year's meeting; Mr. Newman Lawrence speaks of "The Human Body as a Conductor," Mr. Killingworth Hedges on "Anti-friction Materials," and contributions may be expected from Mr. Gisbert Kapp and others. Of the evening lectures, that of Prof. Ewing on "Induction" ought to be a classical essay on the subject.

LEGAL.

Edison Phonograph Company v. Lynd. — In the Chancery Division of the High Court on Friday, before Mr. Justice Chitty, Mr. Byrne, Q.C, appeared in support of a motion for an injunction restraining the defendant, William Lynd, from exhibiting a phonograph, the property of the plaintiff company, and from representing himself to be the agent of the company. Learned counsel said that the defendant was employed by the plaintiff company to exhibit their phonograph in the United Kingdom. He was subsequently discharged, but notwithstanding repeated applications he retained possession of the instrument and continued to advertise himself as the representative of the company. A good deal of correspondence was read, in the course of which defendant, on learning that legal proceedings were about to be taken against him, threatened to make certain exposures and said he would subpœna Mr. Gladstone. The defendant did not appear, and His Lordship granted the injunction as asked until trial or further order.

BUSINESS NOTICES, &c.

The Electric Light in the West End.—Futher additions to the already long list of installations in this district are to be noted. In addition to those published a fortnight ago, we may mention that Messrs. Drake & Gorham are fitting the Law Union and Crown Fire and Life Office, Bell Yard, Strand.—Messrs. Sharp & Kent are fitting up the premises of the Atlas Fire Office, Pall Mall East, W.C, while Messrs. J. Defries and Sons, of Gravel Lane, E.C., are fitting up the office of the District Messenger Service and News Company, adjoining the Hotel Windsor, in Victoria Street, Westminster. —Messrs. Drake and Gorham are fitting up the new premises of the Charing Cross branch of the Credit Lyonnais, in Cockspur Street.—The premises of Messrs. Herring & Lake, Great Portland Street, W., have recently been installed by Messrs. Evans, Stewart, Palmer & Co.—The New Royal Palace Hotel, in Kensington Gardens, now approaching completion, is to be lighted throughout by electricity.—Messrs. Dunaway & Son, of 183, Hornsey Road, N., have recently completed an installation in the premises of Messrs. Holman Bros, tailors, in the Strand, adjoining Exeter Hall.—The Junior Army and Navy Stores, in Regent Street, are extending their private electric lighting plant.—The Electric Wiring and Fittings Company, of Duke Street, S.W., are fitting up an installation in some new residential chambers in Northumberland Street, W., while Messrs. McLellan & Co. are engaged upon some electrical work at 23, Nottingham Place, W.

The Electric Light at the Soothill Wood Colliery. —The installation of electric light at the above colliery is, we under the only one thus far lighted by electricity in that locality. The work has been carried out by Messrs. A. Hirst & Son, electrical engineers, of Foundry Street, who about a year ago fitted up the Crigglestone Colliery with a somewhat similar installation. The Soothill Wood Colliery is illuminated by a dynamo capable of lighting 150 lamps of 16 candle-power, driven by a 12 horse-power engine. The pit bank is lighted with eight 32 candle-power lamps. The porches at the bottom of each pit are lighted with 12 lamps of 16 and 32 candle-powers. At the tip end of the large muck stack a 300 candle-power Sunbeam is fixed, and at the top of the muck road a 100 candle-power lamp is fixed. The railway bank is also lighted with nine lamps of 16 and 32 candle-power, and all the engine houses, screens, &c., are fitted with lamps, the total number of lamps being 85, equal to 132 16 candle-power lamps. The dynamo is stationed in one corner of the fan engine house, and is driven from a special 12 inch cylinder engine. A great amount of ground has had to be covered by the wires, the 300 candle-power Sunbeam being 280 yards distant, the 100 candle-power lamp 360 yards distant, and the railway bank 275 yards, while the farthest lamp at the bottom of the deep pit is 325 yards distant from the dynamo.

Fowler, Lancaster & Co.—Under the title of Electrical Plant and Fittings, Messrs. Fowler, Lancaster & Co., of Birmingham, have compiled with great care and discrimination a new comprehensive catalogue of electric light requirements, with a view of putting before engineers and contractors, in a condensed form, the prices of the chief manufacturers, so as to enable estimates to be readily prepared by reference to this catalogue alone. The position of the compilers as contractors has enabled them to include only what, from their own experience, they know is worthy of recommendation, and in this way the book takes a place hitherto unoccupied. The printing, the illustrations, and the get up of the publication are all excellent, and the arrangement of the contents has been very well done. We are glad to see included in the part devoted to motive power a description and illustration of the Friedrick steam motor, a unique combination of engine and boiler, which has not received from electrical engineers the attention deserved by its exceptional merits as a generator for installations of a moderate size.

Clip Connection.—We illustrate below a form of clip connection for connecting house service wires to copper strip. The drawings explain themselves pretty well. There are three flat strips forming a main, lying one on the top of the other in a way which is common. In fig. 1 the clip is shown in place, clamping down a house service end on these strips. The clip is in two pieces, and so shaped,

FIG. 1.

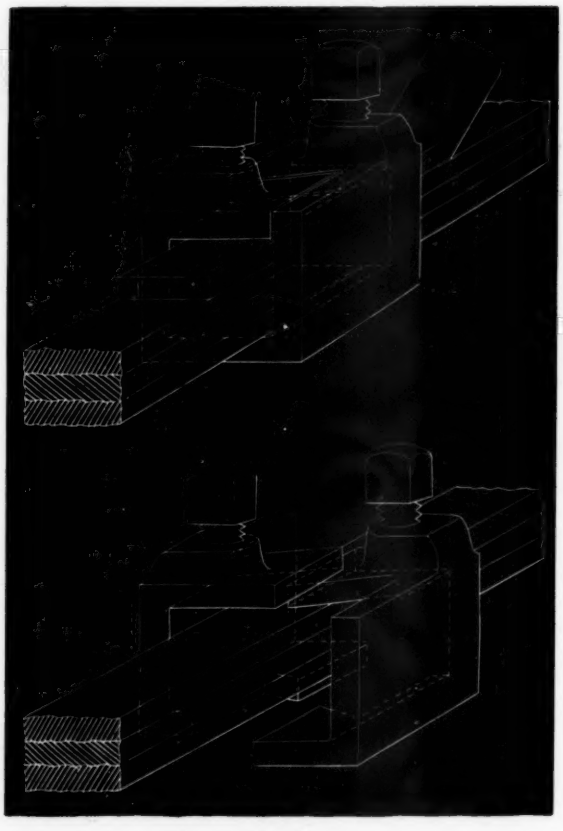


FIG. 2.

that when the fourth strip is in, it cannot fall off, even if the screws should be loose, while when the extra strip is taken out, one half of the clip can be pushed down below the other, and pulled off sideways, as shown in fig. 2. The clip thus makes a purely mechanical connection, one which can be made anywhere along the length of strip, which cannot fall apart, but which can be disconnected with the greatest ease, and without any risk of short circuiting between one line of strip and the next line parallel to it. It has been designed by Mr. B. M. Jenkin, one of Prof. A. B. W. Kennedy's assistants.

Camberwell Electric Lighting.—At a meeting of the Camberwell Vestry last week, the question of electric lighting came up for discussion. After a general feeling had been expressed in favour of its introduction, a grant was unanimously voted to the Commissioners of the Camberwell Baths, for the purpose of forthwith laying down a complete plant at the fine new buildings in course of erection at Camberwell Green, it being also arranged that the services of a consulting engineer should be obtained to advise and superintend the execution of the works. Subsequently the commissioners appointed Mr. Morgan Williams, Assoc. M.Inst.C.E., to

act on their behalf. The contract for the installation, which has been secured by Messrs. B. Verity & Sons, will have to be completed in six weeks, in view of the formal opening of the premises.

Ship Lighting.—Messrs. J. B. Saunders & Co., Cardiff, have just completed an installation of electric light on board the passenger steamship, *Lynton*. The plant consists of a compound Phœnix dynamo, coupled direct to a high speed Robey engine. The current is distributed into three main circuits; one for the fore cabins, one for the aft cabins, and one for the engine rooms, boilers, stores, galleys, and alley ways. A separate circuit is also run for the mast head and side lights, the switch controlling these lamps being fixed in the chart room, in order to meet the Board of Trade regulations.

The contract for the electric lighting of the two new Cunarders, which are now building at Fairfield, has gone to Messrs. Siemens and Halske, of Berlin.

Rashleigh Phipps & Dawson.—The following are a few of the installations Messrs. Rashleigh, Phipps and Dawson are at present carrying out in the City:—J. S. Morgan & Co., 22, Old Broad Street; Mutual Trust Company, 22, Old Broad Street; G. and A. Herring, 123, Bishopsgate Street; Uzilli & Co., 123, Bishopsgate Street; Fitch & Co., 66, Bishopsgate Street; Hill & Son, 60, Bishopsgate Street; Rochester Buildings, 38, Leadenhall Street; Star Life Assurance Company, 32, Moorgate Street. The same firm have 32 other installations, numbering 2,590 lights in hand in London and the country, as well as many fittings' jobs, including five large public buildings.

S.M. Electric Motors.—Messrs. Ernest Scott and Mountain have designed the S.M. motor for the purpose of meeting a long felt want in connection with electric supply companies. These motors are made upon lines dictated by long practice in the designing of dynamos and motors of large capacity, and whilst of small size, are said to embody all the special features in engineering and electrical design necessary to ensure satisfactory working.

Tenders Wanted—West Hartlepool.—The Hartlepool Co-operative Society invite tenders for lighting their new premises in Whitly Street, West Hartlepool, by electricity. Specifications (for which 2s. 6d. will be charged, returnable on receipt of a bonâ fide tender) may be obtained from T. Tweddell, 18, Reed Street, West Hartlepool. Tenders to be in not later than August 12th.

Tenders Wanted — Chertsey.—Tenders are being invited for the construction of telephones, electric bells, and speaking tube at the union workhouse at Ottershaw, for the Chertsey Union, according to a specification, which may be seen at the office of Mr. H. E. Paine, Clerk, Chertsey. Tenders must be sent to the Clerk on or before the 8th inst.

Newington, Priddle & Co.—The employés of Messrs. Newington, Priddle & Co., of Clerkenwell, and their invited guests, went to Great Marlow for their annual outing on Saturday last. From thence they proceeded after dinner in brakes to Henley-on-Thames, and after having tea, the day was pleasantly finished with the return drive to Marlow.

Personal.—Mr. H. B. Bourne has been appointed electrical engineer to the International Okonite Company, as regards their contract for laying mains for the Manchester Corporation.

CITY NOTES.

The Great Northern Telegraph Company.

Le Temps, in noting the large business lately done on the Paris Bourse in the shares of this company (at about 486), gives some interesting details of its past and present position. The telegraph line of this company, we are informed, reaches a distance of 3,510 marine miles in Europe, and 3,496 marine miles in China and Japan. In Europe, the company's cables land in Denmark, Sweden and Norway, Russia, England and France. In the east its cables serve Russia in Asia, China and Japan. The cables in Europe are connected with those of the Far East by the land lines of the Russian Government, between the Baltic Sea and the Pacific Ocean (St. Petersburg-Vladivlostock), about 6,100 English miles. The board of management is composed of Danish members, but it has foreign representatives in Europe and the Far East. It will be seen from the balance-sheets given below that hitherto the position of the company has been very strong. Like all important companies, the Great Northern Company has large reserves to meet working expenses, which are large, and breakages of cables, which are frequent, considering the length of the lines. During the last five years the breakages have been as under: 1887, 11; 1888, 21; 1889, 26; 1890, 27; and about the same last year. Almost all the breakages are caused by fishing apparatus, which international legislation for the protection of submarine cables has subjected to no supervision.*

In order to obviate the inconveniences of these interruptions, the company has lately laid two new cables; but it has been careful, in laying them at the bottom of the sea, to deviate as much as possible from the line followed in the first instance, with a view to avoid the same causes leading to the simultaneous breakage of the parallel cables. The new cables land, one in France and Denmark, the other in England and Sweden. A submarine cable company cannot use its resources with too much foresight. Its reserves should be considerable, however favourable an opinion it may have of the strength of its cables. The Great Northern Company has cables which have been in use more than 20 years. Others, on the contrary, have been renewed, so to speak, from end to end. The Great Northern Telegraph Company encountered, at its inception, great opposition when it proposed to establish aerial lines in China. In 1875 the authorities of that country entered into an agreement with it for the construction of a line between Foochow and Amoy. The first works and plant, however, were destroyed by the inhabitants. Fearing to compromise the question of telegraphs in the future and drawing upon itself the animosity of the Chinese, the company, at the Government's wish, consented to annul the agreement. This cancellation had an important influence on the question of telegraphy in China; thus on the demand of the authorities and at the cost of the Government, the company opened, on April, 1876, a school at Foochow to teach Chinese students the science of telegraphy. A few years later, in 1881, telegraphy in China largely extended. The first telegrams between Shanghai and Tien-Tsin were exchanged on November 29th, 1881. A concession was granted it on June 8th, 1881, by the Chinese Imperial Telegraph Commission, by which it was conceded a perpetual monopoly for its then existing cables, and another monopoly, for 20 years, to land telegraph cables anywhere on the littoral of the Empire. During this time the Government would not permit the construction of aerial lines capable of competing with the company's cables. Yet, in 1884, the Government infringed the spirit and terms of the convention by establishing a line from Foochow to Canton, competing with the company's cables between Shanghai, Amoy and Hong Kong. The first care of the company was to protest against this infraction; but the Chinese Government declared from the first that the said contract should not be recognised as legal; it showed itself still disposed to enter into a new arrangement to replace it. Prepared in advance for this declaration, the company had already drawn up several propositions which, after negotiations between the Chinese authorities and the company's agents in China, led to the signature, on August 10th, 1887, at Chefoo, of a telegraphic convention. This convention arranged that the revenue from all telegrams from or to the towns where the company's cables landed (Shanghai, Foochow, Amoy, Hong Kong) should go to the company, while the revenue of other Chinese towns should belong to the Government. This change took considerable profits from the company. On the other hand, it assured it definitely the correspondence of the towns where its cables landed. The new convention, which was approved by the Viceroy Li Hung Chang, had, to become effective, to be ratified by the Supreme Authority of the Tsong li Yamen at Pekin. Up till now that ratification appears to be wanting. The report of the meeting of April, 1890, stated the impossibility, hitherto, of arriving at a satisfactory solution; but since, at the meetings in 1891 and 1892, the directors have not said a word of the obstacles of an unknown nature which had hitherto suspended the definitive signature of the agreement of 1887. Now, as the application of that agreement would cause the company considerable immediate losses, and as, on the contrary, we find an advancing increase of net receipts, we are entitled to conclude that the parties have remained *in statu quo*; that is, under the concession of 1881.

The tariff question also plays a very important part in the position of the Great Northern Telegraph Company, and it may be imagined that it is not without precautions that it presents itself every five years before the International Telegraphic Conference. Thus, in 1885, the Berlin Conference, and in 1890, that of Paris altered the tariffs in such a manner as to force the Great Northern Company to lower successively the price per word, for instance, between Great Britain and Russia from 87 c. 83 to 63 c. and 1 to 58 c., between France and Russia from 62 c. 30 to 48 c., then to 40 c., and between Europe and the extreme East from 83 c. 33 to 70 c. 80. If the company were able, with a good grace, to consent to these reductions, it was principally by applying, for several years, a large part of its income to the paying off of its loan of 1881, which was paid by January 1st, 1891. The tariff voted by the Paris Conference was applied on July 1st, 1891. There was immediately a sensible fall in receipts. If to this be added the reduction of correspondence caused by the prohibition by the Russian Government of the export of grain, and the losses occasioned by the fall of exchange in the extreme East, it will be seen that the large increase in receipts which had to be noted in the first quarter was largely discounted by the decrease in the second. Indeed, the fall of silver was such in 1891, that the tael, which in August, 1890, could be transferred to Europe at about 6 francs 60, was not at the time worth more than about 4 francs 70, representing a loss of more than 25 per cent. on all the encashments effected in Asia. The loss to the company under this heading in 1891 was 449,492 francs instead of 265,134 francs in 1890. If the Great Northern Company, by a very wise financial policy, has acquired great strength, it is still subject to difficulties. In a country like China, where its relations and its elements of receipts are very important, it is subject, on the part of the authorities, to difficulties of the kind referred to above. Further, the lowering of rates which are voted, every five years, by the International Telegraphic Conference, bring about periodically decreased receipts, which hitherto, it is true, have only been temporary; but which, at a given moment, when the world's trade becomes subject to a depression, might last some years. Finally, the fall in the price of silver is very prejudicial to the company, since its profits which it has to send to

* In November, 1882, a congress of delegates representing a large number of Powers, met at Paris, in order to draw up an agreement for the protection of cables. In that agreement it was said that every breakage or damage to a submarine cable done purposely or by guilty negligence, should be punishable either by imprisonment or fine; but the congress did not think it its duty to propose any control whatever on fishing apparatus which constituted for submarine cables, in the opinion of the companies, a veritable scourge.

Europe, suffer a very sensible loss in the rate of exchange. We annex the figures of the balance-sheets and profit and loss accounts for the last four years. Their simplicity and clearness, which are the evident signs of a prosperous situation, absolve us from making any comments.

ASSETS.

	1888.	1889.	1890.	1891.
Establishment account	50,775	50,775	51,207	53,036
Land	„	432	„	„
New Anglo-Swedish cable	„	„	2,168	„
New Franco-Danish „	„	„	„	2,429
Shares and obligations	12,110	13,196	13,072	13,020
Cash in Europe	120	554	605	849
„ Asia	120	47	20	28
Miscellaneous debtors	1,306	1,247	1,290	1,042
	64,431	66,251	68,362	70,404

LIABILITIES.

Share capital	37,500	37,500	37,500	37,500
Obligations	7,250	6,375	5,750	5,500
Redemption funds	2,750	3,625	4,250	4,500
Reserve and renewal funds ...	14,344	15,449	16,968	18,627
Council	37	37	37	37
Dividend	937	937	1,353	1,354
Miscellaneous creditors	580	1,160	1,299	1,482
Carried forward to following year	1,033	1,168	1,205	1,404
	64,431	66,251	68,362	70,404

PROFIT AND LOSS ACCOUNTS.

DR.	1888.	1889.	1890.	1891.
Appointments	958,875	974,363	992,174	1,028,087
Station and office expenses	214,573	215,060	218,048	218,213
Overlooking and maintenance of wires and cable steamers	239,679	314,825	334,400	247,977
Various instruments ...	83,797	71,458	71,516	19,396
Maintenance of vessels ...	15,811	11,085	11,362	14,419
Travelling expenses... ...	12,589	17,317	14,646	11,158
Bankers' commission ...	71,122	91,352	89,110	85,275
Miscellaneous expenses ...	14,557	10,707	7,637	11,684
Net profits	6,616,982	6,707,641	7,145,684	7,354,944
	8,227,985	8,413,808	8,884,577	8,991,153
Brought forward from preceding year	1,048,029	1,033,648	1,168,057	1,205,406
Net receipts at stations ...	6,503,969	6,695,718	7,022,791	7,117,402
Interest	478,889	518,930	533,175	518,518
Miscellaneous products ...	197,098	165,512	160,554	149,827
	8,227,985	8,413,808	8,884,577	8,991,153

Crompton and Company, Limited.

THE fourth annual general meeting of Crompton and Company, Limited, was held on July 29th at the Cannon Street Hotel, Mr. R. E. B. Crompton (acting chairman), presiding.

Mr. FRANCIS R. REEVES (the secretary) having read the notice convening the meeting, the report and accounts were taken as read.

The CHAIRMAN: Gentlemen, I have now to move: "That the directors' report and statement of accounts for the year ending March 31st, 1892, be received and adopted." I am happy to say that the remarks I have to make on the subject of the report will be very brief. Happy is that company that has got nothing to explain away, and I think that is our case. We have carried on the year's business in a manner which has been sufficiently satisfactory to us. No doubt we should have liked to have shown larger profits, but the reason we have not shown larger profits is not because there has been any want of economy in working, for I think we have arrived at a higher point of economy than we have ever reached before, but it is simply due to the fact that there has been greater competition, and consequently prices have been reduced, and the margins available for profit on our different orders have not been so large as usual. Our electric business is one, as you may know, which is a progressive one, and demands great sacrifices on the part of manufacturers. Large sums have to be devoted to improvements, and these sums, practically, are taken away from the profits of the year. It is quite impossible to sub-divide them up, and put them to a suspense account. None of the works that have been carried out during the year require any special comment. We have taken our share of the contracts that have been going, and we have completed a certain number of large contracts with which our name has been published, such as the Notting Hill and Westminster, and other London contracts. We have completed a contract, also, for the lighting of the City of Pretoria, in South Africa. At the present moment, we are in treaty for several large contracts of the same kind; but, for obvious reasons, I do not mention them. Our prospects of profit in connection with these contracts, if obtained, will be at least as good as they have been in the past, and as our economy in working has been constantly progressive, I hope that if we obtain these contracts we shall be able to show at least as good a profit in the future, if not a greater. The money that we spent on experiments in connection with electrical haulage has turned out to be very remunerative. We are receiving orders for electrical haulage plant, and it already occupies a very large portion of our order sheet. The next point I must notice is that we have no trouble whatever with our workmen. We find that the state of good feeling which has existed between our workmen and ourselves still continues. We have tried, during the year, an experiment of a very interesting nature. That is to say, we have issued a certain number of our debentures to our workmen and under such terms, that, although the workmen have the perfect security which the debentures afford, they are allowed to participate in the profits of the undertaking by having the interest they receive on these workmens' debentures raised to the rate of interest which is paid on the ordinary shares. That virtually makes our workmen partners with us in the undertaking, and I hope it will have a good effect in the future. The scheme has been working such a short time that it is impossible for it to have "told" as yet, but the fact that those who have taken these debentures are men such as our foremen and chief managing clerks, and others who can materially influence our profits, is a very encouraging sign. I have further to say that we have been for some time past, as you are aware, in the position of having no chairman. I am glad to tell you that one of our directors—Lord Emlyn, who has served for some time on our board, now states that his engagements are such that in the course of the next year he can take the position of chairman, which will, I need hardly say, be a great relief to me. My work as managing director is sufficiently engrossing and takes up so much time, that it is quite impossible that I can do justice to both offices, and I therefore think it would be a very great advantage to us for a man of such well-known and well-tried business capacities as Lord Emlyn to occupy the position of Chairman. I have to tell you that in accordance with what was said to you last year we propose to issue the balance of the preference shares, and it would be a great advantage to us and to the existing shareholders that that balance should be issued, as it would enable us to obtain a Stock Exchange quotation for our shares. The same remark applies to the very small balance of debentures that yet remain unissued. As soon as those two balances are issued, we shall be in the position of being able to obtain a Stock Exchange quotation for the whole of our preference shares and debentures, and no doubt many will consider that as a very great advantage. I think you will agree with me, that after taking into consideration the reduction of prices due to competition, and the fact that the trade as a whole has been rather on the decline during the latter half of this year, that the profits earned are very satisfactory, and that they require no further comment on my part. These profits have been earned by cutting down expenses to the very greatest possible extent, and I think we have greatly to thank our administrative staff for the results obtained. I conclude by moving, "That the directors' report and statement of accounts for the year ending March 31st, 1892, be received and adopted."

VISCOUNT EMLYN seconded the motion.

Mr. TUFNELL, sen., said he could but congratulate the directors upon the very satisfactory character of the report. Looking at the steady progress which the company appeared to be making, the profitable business they seemed to be doing, and the admirable way in which the company was managed, and to the increase which had lately taken place in the number of directors, especially considering that that increase included the valuable addition of Lord Emlyn, who he should be very pleased to see as chairman of the company. Looking at all those facts, he would like to suggest that the remuneration of the board be increased from £1,000 to £1,300.

Mr. HANCOCK said he would be very pleased to second such a proposition.

The CHAIRMAN said it would be better if Mr. Tufnell's motion came after the adoption of the report. He then put the resolution for the adoption of the report, and it was carried unanimously.

The CHAIRMAN then proposed the following resolution, "That a dividend of 3s. 6d. per share, being at the rate of 7 per cent. per annum for the half-year ending March 31st last be declared and paid on the preference shares of the company."

Mr. BERNARD GIBSON seconded, and the motion was carried, as was also the following, which was proposed by the chairman, and seconded by Mr. H. H. J. W. Drummond, "That a dividend of 4s. 6d. per share, making, with the interim dividend, 7 per cent. per annum, be paid on the ordinary shares of the company."

The CHAIRMAN then proposed the re-election of Mr. C. F. Tufnell as a director of the company. He said Mr. Tufnell had been a director from the very first, and he was one of the hardest workers on the board.

Mr. PAYNE seconded the motion, which was carried.

The auditors, Messrs. J. H. Duncan & Co., having been re-elected, Mr. TUFNELL, sen., proposed his motion with reference to increasing the remuneration of the directors by £300.

Mr. HANCOCK seconded, and the motion was unanimously carried.

The CHAIRMAN, in reply, said: Gentlemen, I have to thank you for the resolution you have just passed, which I am sure will be greatly appreciated. As I have already said, the directors of this company have had no easy task. Such business as ours is one which entails perpetual anxieties and troubles on the board of management, and I think our success is not less than other peoples. But the fact that we have so far sailed along pleasantly and avoided troubles is greatly due to the tact and management of the board, and I think you may felicitate yourselves on having such a good body of directors.

Mr. TUFNELL, sen., then proposed a vote of thanks to the chairman for presiding, and to Mr. Reeves, the secretary, for the able conduct of the company's business.

Col. WOOD, C.B., seconded, and the motion was carried.

The CHAIRMAN having briefly acknowledged the vote, the proceedings terminated.

The Direct United States Cable Company, Limited.

THE thirtieth ordinary general meeting of the above company was held on Friday last at Winchester House, Old Broad Street, Sir John Pender, K.C.M.G., M.P., presiding.

The SECRETARY (Mr. T. Finnis), read the notice convening the meeting, also the minutes of the last ordinary general meeting.

The CHAIRMAN said that before moving the adoption of the report, he would, as usual, go over some of the figures which referred to the last six months' operations, so that they could have a perfect idea of the working of the business. The revenue for the half-year to June 30th last, after deducting outpayments, amounted to £39,015, and the working and other expenses, including income-tax and depreciation of spare cable, to £19,019, leaving a balance of £19,996 as the net profit of the half-year, making, with £4,983 brought forward from the previous half-year, a total of £24,979, which had been appropriated as follows:—Interim dividend of 3s. 6d. per share for the quarter to March 31st, £10,624; proposed final dividend of 3s. 6d. per share for the quarter to June 30th, £10,624; balance proposed to be carried forward, £3,731; total of £24,979. The revenue, as compared with that in the corresponding period of last year, showed an increase of £1,662. That was not a large improvement, but business generally had not been brisk during the period under review. The expenses in London showed a small reduction in salaries and a small increase in printing and stationery, the other items being practically the same as before. Those disemblursements were on the whole £24 less than in the corresponding period. The expenses at stations also showed a small reduction in salaries, and a considerable reduction in maintenance, on the other hand, rent and taxes were somewhat high. The station expenses on the whole had absorbed £140 more than for the corresponding period, the further general expenses showed a reduction in directors' remuneration, and a small increase in law charges, but taking the normal working expenses as a whole, they were only £49 in excess of the corresponding period, £17,604, against £17,555. The remaining items charged against revenue were income-tax, the depreciation of spare cable, and freight of cable; they were items which were scarcely under the directors' control, and it was to those items alone that the increase was shown on the whole of the expenditure was due. Turning to the reserve fund account, it would be seen on the credit side that the interest on the investments amounted to £4,421, while on the other side, there was charged for the expenses of repairs to cables £9,385, leaving the balance of the reserve standing at £254,716. Referring to their Duplex system of cables, he thought that the system was probably one of the most remarkable inventions since submarine cables became a property, because it had practically doubled the working power of their cables. He had always looked upon it that if they had not had them duplexed they would probably have required more cables, but with the cables they had there was a great deal more carrying power just now than was fully paid for. The investments remained unaltered since the last meeting, and their present market value continued much higher than the figure of cost at which they stood in the account. That completed a brief summary for the half-year, but it must be borne in mind that the June six months was always a lean period, and no fair idea could be obtained of the working for the twelve months as a whole, and thus it would be seen that the company, after paying all expenses, including somewhat heavier repairs than usual, together with the customary dividends of 3½ per cent. had fully maintained its position during the half-year. He had given the hard facts connected with their system. He would have been pleased if he could have told them that their dividend power was increasing, but unfortunately the amount of cable power now in the Atlantic, taking with it the duplex system, was equal to something like twenty cables. He remembered the time in the earlier days, submarine telegraphy in the Atlantic, when the difficulty was to get as much money as would lay one cable, but that first cable was laid after great difficulties. It was duplicated; then America began to take heart, and they found cables as well; the result was that they were labouring with a surfeit of cables in the Atlantic. He hoped it was a lesson to those who were looking towards that field for a harvest in the future, for they had spent a great deal more than they were at the moment reaping a return upon. During the six months they had had some very great changes. Their friends had been passing away: friends who were associated with submarine telegraphy since its inception. He referred to Cyrus Field, who was one of the active spirits in the earlier times of submarine telegraphy, particularly of the Atlantic. Field's energy was indomitable. After a few remarks regarding Mr. Field's career, and the success attending his efforts, the chairman referred to the deaths of two of the directors of the board, Mr. Wm. Ford and Admiral R. C. Mayne. He remarked that no reference had been made to the French suit in the report, because the board were sick of seeing it there, without being able to give any definite information with regard to it. They would keep a strict watch upon it, and he should be immensely pleased if during his lifetime he should be able to announce that a decision had been come to. As he had often said, submarine telegraphy was a great barometer of trade, which was affected for good or bad according to the state of the political horizon. Until things generally were settled upon a firm, sound basis, trade would not grow. Trade depended upon confidence. In conclusion, he moved the adoption of the report, and the declaration of a final dividend of 3s. 6d. per share, free of income tax, making, with the interim dividend already paid, a total dividend of 3½ per cent. for the year ended the 30th ult.

Mr. E. M. UNDERDOWN, Q.C., seconded the motion. The resolution was carried unanimously, and motions were also passed re-electing Mr. C. J. Gunther and Admiral of the Fleet the Hon. Sir Henry Keppel, to their seats at the board, and reappointing John G. Griffiths and Mr. John Sawyer auditors.

In reply to a vote of thanks to the chairman and directors, the chairman expressed his belief that the submarine cable system had done a great deal not only to promote the commerce of the country, but also to knit the world more closely together. Some of them might think that at his time of life he had acted foolishly in seeking to enter Parliament again, especially after having had all the comforts and enjoyment of six years out of it. There were, however, times in the history of a country when the oldest and the youngest felt that they had a duty to perform. He had looked on the present period as a period of crisis in the country, and he had not liked the idea of being out of the fray in maintaining the integrity of the empire, of which they were all so proud, and which many of them had taken an active part in building up.

The proceedings then terminated.

Anglo-American Telegraph Company.

THE Marquis of Tweeddale presided over the half-yearly general meeting of the proprietors of this company, which was held last Friday at Winchester House, Old Broad Street.

In moving the adoption of the report and accounts, the CHAIRMAN observed that the report contained two announcements of a painful character. One was the death of their much-esteemed and greatly distinguished colleague, Mr. Cyrus Field, to whose memory and ability he paid a warm tribute, describing him as "the pioneer of ocean telegraphy." The second incident was the appalling calamity which had befallen the town of St. John's, Newfoundland, where they owned land, lines, and stations. They had sustained some loss, but nothing compared to that inflicted upon the inhabitants of the town, and he hoped the shareholders would approve the action of the board in contributing 100 guineas to the relief fund, and of conveying messages gratuitously. It was a source of satisfaction to be able to point to a steady, if slight, increase in the traffic receipts, amounting to some £10,000. Unluckily, the expenses had increased also, so that, unfortunately, a comparatively small proportion only was available for dividend. The expenses of the steamship *Minia* were about £3,000 more than last year, mainly because of the repairs required by the Board of Trade. The working expenses were some £2,000 more, due almost exclusively to the expenditure rendered necessary through the active competition which prevailed for business between this country and America. Last time the *Minia* earned some £1,500, while this half-year it had earned nothing. The net result was a revenue of £3,500 over and above that of the previous half-year available for dividend, or just sufficient to pay 1s. per cent. for the previous half-year. In view of the extraordinary depression which had prevailed since the Baring crisis and the complication from the Atlantic traffic, he did not think that the results could be regarded as altogether disappointing. He could but believe that the day would come when the rival companies would see the advantage of coming to some arrangement by which the enormous amount spent—he might almost say squandered—in competition, might be saved without the public in any way suffering, but possiby benefiting. Until such a state of things came to pass, he could hold out no hope of a diminution of expenses. The renewal fund was of interest to all classes of shareholders, but, owing to the large expense attending the repairs of cables, and especially the Brest cable, which was laid over a precipice, he did not think the time had arrived when they could add the interest to the dividend fund. The Brest cable had again broken very near the same point where it broke before, and its repair would involve considerable expense. Considering that the report covered a period of extreme commercial depression, he thought they were justly entitled to look forward to a better state of things in the future. Meanwhile, it was the duty of the directors to maintain the cables in the high state of efficiency for which they had hitherto been distinguished, and they all hoped for a greater share of public support than they enjoyed at present.

Mr. FRANCIS A. BEVAN (deputy chairman) seconded the motion, and a short discussion followed.

Mr. VAUGHAN asked with respect to the Brest cable, which cost them between £20,000 and £25,000 a year to repair, whether it would not be cheaper to leave it to rot at the bottom of the sea. That would give them another 1 per cent. dividend.

The CHAIRMAN: No; only ⅞ per cent.

In reply, the CHAIRMAN admitted that the Brest cable was most disappointing; but if they did not keep up their communications with France, they would not get any French messages. He did not see how they could honestly remodel their affairs, and give the deferred shareholders some dividend. The dividends were declared on the ordinary stock, and the deferred holders only got what was left.

The motion for the adoption of the report and accounts was then agreed to, and the usual compliment to the chairman terminated the proceedings.

The Kensington & Knightsbridge Electric Lighting Company, Limited.—An interim dividend has been declared on this company's ordinary shares at the rate of 4 per cent. per annum for the half year ending June 30th, 1892.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 31st, 1892, amounted to £735; corresponding month, 1891, £692, increase £43; total receipts to date for half-year, £3,784; corresponding period, 1891, £3,477; increase £307.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of July, were £3,100, as compared with £3,186 in the corresponding month of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 29th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, amounted to £3,028.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, July 28th.	Closing Quotation, August 4th.	Business done during week ending August 4th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —103	99 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	47½— 48½xd	47½— 48½xd	47⅝	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½— 88½xd	87½— 88½xd	...	...
2,849,510*l*	Do. do. Deferred	Stock	11 — 11⅛	11 — 11⅛	11 1/16	...
130,000	Brazilian Submarine Telegraph, Limited	10	10¼— 10⅜	10¼— 10⅜	10⅜	10¼
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	99 —102 xd	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝— 3⅛	2⅝— 3⅛	3 1/16	2 15/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2⅛
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	9¾— 10¼	9¾— 10¼	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	160 —165	160 —165	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛— ⅜	⅛— ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11¾	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11⅝	11½— 11⅝	11⅝	11⅝
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝— 15xd	14⅝— 14¾xd	15	14⅝
70,000	Do. 6 p. c. Preference	10	15¼— 15⅝xd	15¼— 15⅝xd	15⅝	15⅜
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	106 —109 xd	107	106½
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	111	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15¼	15
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	102 —105	102 —105	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110xd	107 —110 xd	...	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	101 —104	101 —104	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	101 —104 xd	101½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4⅜— 5¼	4⅜— 5¼	5	4⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1½— 1⅝	1 — 1⅛	1 1/16	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛— 2⅜	2⅛— 2⅜	2⅜	2¼
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅛— 1⅜	1⅛— 1⅜	1¼	1⅛
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10 — 10¼xd	10 — 10¼xd	10¼	10⅛
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼xd	15 — 15¼xd	15⅜	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18½— 19	18 13/16	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7¾— 8¼	6 — 7	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20½— 21½	20½— 21½	21½	20⅞
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 42	41 — 43	42	41½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 1/16	5⅛	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅜— 7¼	6⅜— 7¼	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4⅜— 4⅞	4 15/16	4 11/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13½— 14xd	13½— 14 xd	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13 — 13½xd	13 — 13½xd	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	109 —111	109 —111	110½	109¾
250,000*l*	Do. (issued at 5 p.m., all paid)	...	109 —111	109 —111	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛— ¼	⅛— ¼	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¼— 7⅜xd	7¼— 7⅜ xd	7 5/16	7⅛
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅛— 8xd	7⅜— 8¼ xd	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3⅛	3 — 3½	3⅜	...
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45½	45¼
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6 — 8xd	6 — 8 xd	7¼	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3 — 4	3⅜	3 5/16
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 —105	102 —106	104½	103½
67,007	Western and Brazilian Telegraph, Limited	15	8⅜— 9¼	8⅜— 9¼	9	8⅝
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅝	6¼
30,364	Do. do. do. 5 p. c. Deferred	7½	2⅜— 3¼	2⅜— 3¼	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	102 - -105 xd	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	102 —105 xd	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1⅝	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼— 9⅜	9¼— 9⅜	9⅜	9¼
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	102 —106	102 —106	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6¼	5⅜— 6¼	6 1/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3½.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅞—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—½.—Do. Debentures, 103—½.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ½—¾.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅜—1½.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892)

ON A PERMANENT MAGNETIC FIELD.*

BY W. HIBBERT, A.I.E.E., F.I.C.

THE growth of the modern idea of a magnetic circuit suggested the possibility of obtaining a standard magnet in a way that would be largely independent of the peculiarities of different brands of steel, as well as of the various physical conditions caused by differences in tempering.

I provided a short straight bar magnet, with a couple of arched pole pieces, of such length and sectional area that there was left between them a narrow air gap of very small magnetic "resistance." A very flat coil of wire thrust in or out of this gap, gave electro-magnetic impulses whose value was fairly constant. Experience with these simple instruments led me to believe that a more rigorous application of the principle would give a truly permanent magnetic field.

Fig. 1 is a general view of the instrument which resulted from the

FIG. 1.

experiments. Fig. 2 is a vertical section of the magnetic circuit. In this, N, S, is a cylindrical steel rod, 2½ inches long and 1 inch in diameter, attached to two cast iron pole pieces. The upper pole piece, *a*, *a*, is a circular disc, 4 inches in diameter and ⅝ths inch thick, carefully bored to fit the upper end of N, S. The lower pole piece, *b*, *b*, is nearly hemispherical, and about ½ inch thick in the wall. This is attached to the steel rod by means of an iron pin, let into N, S, and screwed into *b*, *b*.

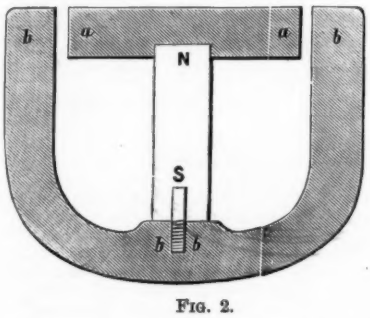


FIG. 2.

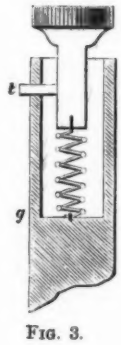


FIG. 3.

The opposed faces of the pole pieces are carefully turned in the lathe, so as to leave between a circular air gap less than $\frac{1}{16}$th inch wide.

The above description gives the form and dimensions of the magnetic part of the instrument. It is magnetised after being put together by a current sent through a coil wound on the steel rod.

The other parts consist of:—

1. Mechanical arrangements which will rigidly preserve the pole pieces in position.

2. Arrangements which will carry and guide a coil of wire as it is thrust through the field in the very narrow air gap. Screwed to the upper surface of the disc, *a*, *a*, is a brass casting with three projecting lugs, *l*, *l* (fig. 1). These lugs are screwed both to small blocks attached to the hemispherical pole piece, and also to the tops of three brass pillars (fig. 1).

The coil is wound in a shallow groove cut on the outside of a brass ring, which is turned thin enough in the wall to slide freely through the air gap. Attached to its upper edge are three arms which radiate from a central boss, the latter sliding up or down on the central guide rod, *g* (fig. 1). The radial arms support an ebonite disc on which are fixed the terminals of the coil.

At the upper end of the guide rod, *g*, is an arrangement for allowing the ring to fall whenever the experimenter desires. The upper end of *g* is bored out (fig. 3), and a horizontal slot is cut in the thin wall thus made. In the inner space and connected with the milled head is a rod, from the side of which projects a tooth, *t*, passing through the slot, whilst from the lower end passes a spiral spring also fixed into the body of *g*. The tooth, *t*, is thus kept in a definite position, from which it can be moved aside either by a rotation of the milled head, or by the upward movement of the boss connected with the ring. On the inner edge of the boss is a slot through which *t* can pass, but cut slightly on one side of the zero position of the tooth. When an electro-magnetic impulse is desired the coil is raised so that the boss, and therefore the ring, rests on *t*. The position of *t* and the height of the ring are so chosen that when the ring is at rest on *t* the coil is altogether above the gap. By a simple rotation of the milled head the coil can be made to fall through the field at any desired moment. The electro-magnetic impulse then given to the circuit is, of course, equal to the number of lines inter-linked with the coil during the fall, multiplied into the number of turns of wire in the coil.

Three instruments of the type just described have been made and tested. The means adopted for testing was to compare two throws of a galvanometer needle, one produced by the discharge of a condenser, the other produced by the magneto inductor.

The condenser employed was a mica condenser of 0·333 microfarad capacity. The potential difference for charging was obtained from four accumulators, whose electromotive force was determined by comparison with a Latimer Clark cell, the comparison being made by the potentiometer method.

Having first taken a fair number of observations from the condenser, a corresponding number were taken from the magneto inductors, the resistance in circuit with each being adjusted till the throw was practically the same as that obtained from the condenser.

Before giving the results it will be proper to state the chief differences between the instruments numbered I., II., and III. in the Table.

Hemisphere No. I.—Air-gap a little more than $\frac{1}{16}$th inch and not quite uniform. Magnetised by flashing current from four accumulators, July 29th, 1890. Heated and cooled several times on different days. Very small decay to August 11th, on which day the number of lines = 21,007. Next day, August 12th, 1890, lines = 21,120. Seven months later, March 14th, 1891, lines = 21,035. Accident to coil caused me to take to pieces and magnetise afresh. A current flashed through at a temperature of about 50° C.

Hemisphere No. II.—Most highly finished. Air-gap rather less than $\frac{1}{16}$th inch. Magnetised by flashing. Lines about 34,000. Nearly 50 per cent. greater than in I. This showed tendency to fall. I therefore adopted the method known as "reducing," by sending reverse current through magnetising coil. Reduction of field about 5 per cent.

Hemisphere No. III.—Magnetic system not so well supported as in two previous instruments. Magnetised by flashing current, and then "reduced" about 20 per cent.

The figures in the column headed "No. of Lines" are obtained by the expression

$$N = \frac{100\,C\,V\,R}{t} \cdot \frac{d'}{d};$$

where C = capacity of condenser in microfarads,
V = potential difference in volts,
R = resistance in circuit with magneto-coil,
t = number of turns of wire on magneto-coil,
d', *d* = throws from magneto-inductor and condenser respectively.

The factor 100 translates from practical to absolute units.

Date.	Temperature of Inductor.	Lines in Inductor Field.		
		No. I.	No. II.	No. III.
April 16, 1891	50° C.	22,030		
„ „ „	20	21,790		
„ 22 „	12·5	21,730		
„ 23 „	13·5	21,710	32,360	
May 8 „	16·5	21,710	32,420	
„ 23 „	13	21,680	32,330	
„ 27 „	13·5	...	...	29,140
„ 30 „	16	21,720	32,410	29,290
June 6 „	18	21,720	32,380	29,270
„ 12 „	22	21,780	32,470	29,260
„ 29 „	21·5	21,720	32,345	29,290
July 10 „	19	21,790	32,510	29,500
„ 27 „	20	21,700	32,470	29,550
„ 31 „	17·5	21,780	32,460	29,530
Sept. 22 „	16	21,690	32,400	29,470
Nov. 10 „	13	21,700	32,400	29,480
Density of lines in air-gap per sq. cm.	...	515	770	700

* Abstract of paper read before the Physical Society on December 4th, 1891.

There is practically no evidence of magnetic decay in seven months. Such small changes as are indicated point the other way, but I am inclined to attribute most of them to slight inaccuracy of the temperature correction for the resistances of the circuit.

The two instruments that were reduced by a demagnetising current (Nos. II. and III.) show a tendency to rise. This tendency is most marked in the instrument which was reduced most. It is evident that only a slight reduction is to be allowed.

No. I., which was magnetised warm, but not "reduced," fell while cooling, and then showed a very slight tendency to increase. It is better than the other two, and is constant enough to be used for any purpose for which an earth inductor is employed.

ON A NEW FORM OF AIR LEYDEN, WITH APPLICATION TO THE MEASUREMENT OF SMALL ELECTROSTACTIC CAPACITIES.*

BY LORD KELVIN, P.R.S.

IN the title of this paper as originally offered for communication "Air Condenser" stood in place of "Air Leyden," but it was accompanied by a request to the secretaries to help me to a better designation than "Air Condenser" (with its ambiguous suggestion of an apparatus for condensing air), and I was happily answered by Lord Rayleigh with a proposal to use the word "leyden" to denote a generalised Leyden jar, which I have gladly adopted.

The apparatus to be described affords, in conjunction with a suitable electrometer, a convenient means of quickly measuring small electrostatic capacities, such as those of short lengths of cable.

The instrument is formed by two mutually insulated metallic pieces, which we shall call A and B, constituting the two systems of an air condenser, or, as we shall now call it, an air leyden. The systems are composed of parallel plates, each set bound together by four long metal bolts. The two extreme plates of set A are circles of much thicker metal than the rest, which are all squares of thin sheet brass. The set B are all squares, the bottom of which is of much thicker metal than the others, and the plates of this system are one less in number than the plates of system A. The four bolts

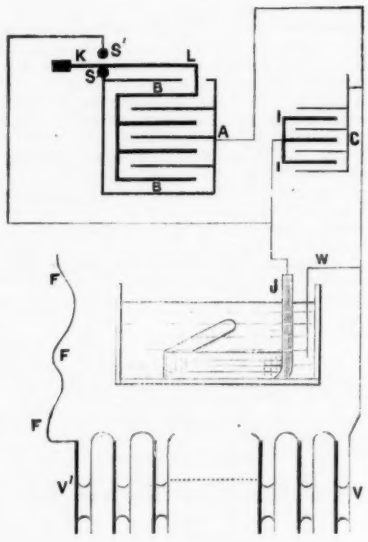


FIG. 1.

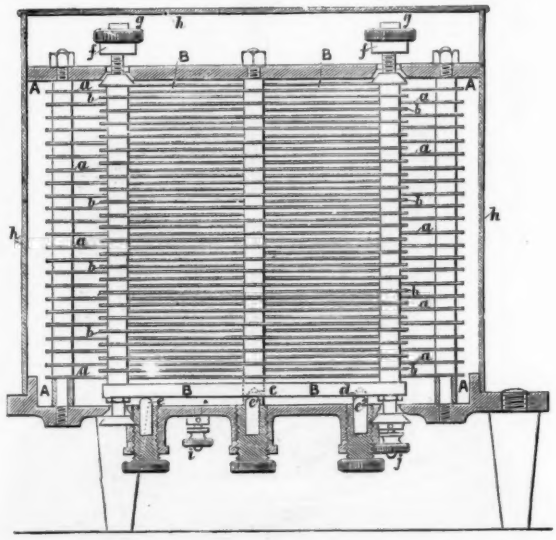
binding together the plates of each system pass through well-fitted holes in the corners of the squares; and the distance from plate to plate of the same set is regulated by annular distance pieces which are carefully made to fit the bolt, and are made exactly the same in all respects. Each system is bound firmly together by screwing home nuts on the ends of the bolts, and thus the parallelism and rigidity of the entire set is secured.

The two systems are made up together, so that every plate of B is between two plates of A, and every plate of A, except the two end ones, which only present one face to those of the opposite set, is between two plates of B. When the instrument is set up for use, the system B rests by means of the well-known "hole slot and plane arrangement,"† engraved on the under side of its bottom plate, on three glass columns which are attached to three metal screws working through the sole plate of system A. These screws can be raised or lowered at pleasure, and by means of a gauge the plates of system B can be adjusted to exactly midway between and parallel to the plates of system A. The complete leyden stands upon three vulcanite feet attached to the lower side of the sole plate of system A.

In order that the instrument may not be injured in carriage, an arrangement, described as follows, is provided, by which system B can be lifted from off the three glass columns and firmly clamped to the top and bottom plates of system A.

The bolts fixing the corners of the plates of system B are made long enough to pass through wide conical holes cut in the top and bottom plates of system A, and the nuts at the top end of the bolts are also conical in form, while conical nuts are also fixed to their lower ends below the base-plate of system A. Thumbscrew nuts, *f*, are placed upon the upper ends of the bolts after they pass through the holes in the top plate of system A.

When the instrument is set up ready for use these thumbscrews are turned up against fixed stops, *g*, so as to be well clear of the top plate of system A; but when the instrument is packed for carriage they are screwed down against the plate until the conical nuts mentioned above are drawn up into the conical holes in the top and bottom plates of system A; system B is thus raised off the glass pillars, and the two systems are securely locked together so as to prevent damage to the instrument.



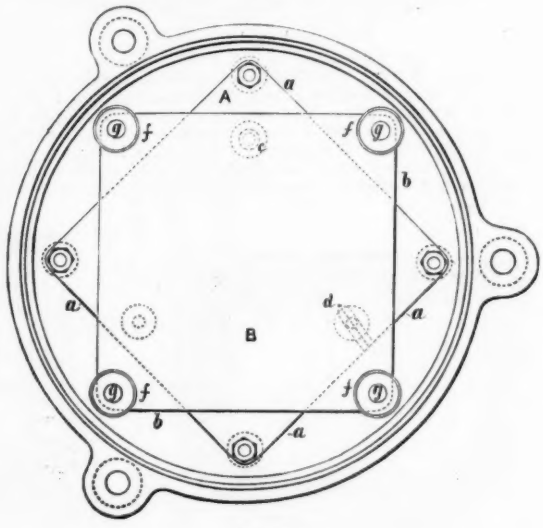


FIG. 2.

A dust-tight cylindrical metal case, *h*, which can be easily taken off for inspection, covers the two systems and fits on to a flange on system A. The whole instrument rests on three vulcanite legs attached to the brass plate on system A; and two terminals are provided, one, *i*, on the base of system A, and the other, *j*, on the end of one of the corner bolts of system B.

The air leyden which has been thus described is used as a standard of electrostatic capacity. In the instrument actually exhibited to the Society there are 22 plates of the system B, 23 of the system A, and therefore 44 octagonal air spaces between the two set of plates. The thickness of each of these air spaces is approximately 0·301 of a centimetre. The side of each square is 10·13 cm., and therefore the area of each octagonal air space is 85·1 sq. cm. The capacity of the whole Leyden is therefore approximately $44 \times 85{\cdot}1/4\pi \times {\cdot}301$", or 989·8 cm. in electrostatic measure. This is only an approximate estimate founded on a not minutely accurate measurement of dimensions, and not corrected for the addition of capacity, due to the edges and

* Royal Society, received May 31st, 1892.

† Thomson and Tait's "Natural Philosophy," Sec. 198, example 3.

projecting angles of the squares and the metal cover. I hope to have the capacity determined with great accuracy by comparison with Mr. Glazebrook's standards in Cambridge.

To explain its use in connection with an idiostatic electrometer for the direct measurement of the capacity of any insulated conductor, I shall suppose, for example, this insulated conductor to be the insulated wire of a short length of submarine cable core, or of telephone, or telegraph, or electric light cable, sunk under water, except a projected portion to allow external connection to be made with the insulated wire.

The electrometer which I find most convenient is my "multicellular voltmeter," rendered practically dead-beat by a vane under oil hung on the lower end of the long stem carrying the electric "needles" (or movable plates). In the multicellular voltmeter used in the experimental illustration before the Royal Society, the index shows its readings on a vertical cylindric surface, which for electric light stations is more convenient than the horizontal scale of the multicellular voltmeters hitherto in use; but for the measurement of electrostatic capacity the older horizontal scale instrument is as convenient as the new form.

To give a convenient primary electrification for the measurement, a voltaic battery, V V', of about 150 or 200 elements, of each of which the liquid is a drop of water held up by capillary attraction between a zinc and copper plate about 1 mm. as under. An ordinary electric machine, or even a stick of rubbed sealing-wax, may, however, be used, but not with the same facility for giving the amount of electrification desired as the voltaic battery.

One end of the voltaic battery is kept joined metallically to a wire, W, dipping in the water in which the cable is submerged, and with the case, C, of the multicellular, and with the case and plates, A, of the Leyden, and with a fixed stud, S, forming part of the operating key to be described later. The other end of the voltaic battery is connected to a flexible insulated wire, F F F, used for giving the primary electrification to the insulated wire, J, of the cable, and the insulated cells, I I, of the multicellular kept metallically connected with it. The insulated plates, B, of the Leyden are connected to a spring, K L, of the operating key referred to above, which, when left to itself, presses down on the metal stud, S, and which is very perfectly insulated when lifted from contact with S by a finger applied to the insulating handle, H. A second well insulated stud, S', is kept in metallic connection with J and I (the insulated wire of the cable and the insulated cells of the multicellular).

To make a measurement the flexible wire, F, is brought by hand to touch momentarily on a wire connected with the stud, S', and immediately after that a reading of the electrometer is taken and watched for a minute or two to test either that there is no sensible loss by imperfect insulation of the cable and the insulated cells of the multicellular, or that the loss is not sufficiently rapid to vitiate the measurement. When the operator is satisfied with this he records his reading of the electrometer, presses up the handle, H, of the key, and so disconnects the plates, B, of the Leyden from S and A, and connects them with S', J, I. Fifteen or twenty seconds of time suffices to take the thus diminished reading of the multicellular, and the measurement is complete.

The capacity of the cable is then found by the analogy:—As the second reading of the electrometer is to the excess of the first above the second, so is the capacity of the Leyden to the capacity of the cable.

A small correction is readily made with sufficient accuracy for the varying capacity of the electrometer, according to the different positions of its movable plates, corresponding to the different readings, by aid of a table of corrections determined by special measurements for capacity for the purpose on the multicellular.

FINAL HEARING ON EDISON'S "FEEDER AND MAIN" PATENT FOR ELECTRICAL DISTRIBUTION.—II.

THE DEFENDANT'S CASE.

THE complainant has sought, with much persistence, to introduce considerations which seem to have no proper bearing upon the interpretation of the patent, but serve merely to obscure the real issue, hence it will be useful to state at the outset the defendant's view as to the real nature of the alleged invention of the patent in suit. The particular subject-matter with which the patent purports to deal is electric pressure or tension, and the alleged invention purports to provide a remedy for the drop or fall in electric pressure, due to the resistance of the main conductors. It is practically impossible to formulate any intelligent definition of electric pressure or tension without recourse to fluid analogies, and such analogies are serviceable, not alone as illustrations, but because it is a fact generally accepted among scientific men, that so far as concerns the general laws of flow and distribution, electricity behaves in all substantial respects as if it were a fluid. The patent states that where the main conductors of a system of electrical distribution extend to a great distance from the central station, and supply a large number of transmitting devices, there is inevitably a difference in tension between the various parts of the circuit, due to the resistance of the main conductors. The specification says:

"This may be partially remedied by making the conductors very large near or at the station, gradually decreasing their size or conducting capacity; but such plan only lessens slightly the ratio of fall."

The latter part of this statement is not true as a matter of fact. The difficulty could be entirely remedied, as admitted by complainant's expert, Prof. Chandler, by increasing sufficiently the size of the conductors. The patentee then describes the remedy he proposes for the difficulty, by the use of special feeding conductors, "having no translating devices connected therewith," and further on describes the manner in which the feeding conductors and the main conductors of the consumption circuit are to be proportioned, or, in other words, how their relative sizes are to be adjusted. The specification states, in substance, that the circuit consists of two essential parts, the "feeding conductors" and the "main conductors of the consumption circuit." It is obvious that by reason of the mere form of the circuit, irrespective of its proportions, any drop in pressure on the feeding part of the circuit cannot affect the relative pressure in different parts of the consumption circuit, or the relative candle-power of lamps connected with that circuit at different points. The specification says that the main conductors "should be so proportioned that the drop upon them shall not exceed a definite small limit." No instructions are given, here or elsewhere, in the specification, as to how this result is to be secured. No instructions are given as to any definite proportions, either of the main or the feeding circuit, nor what the "definite small limits" is, nor what variation in candle-power is permissible. Taking all the statements together, they merely direct the constructor to proportion the consumption mains (if he knows how to do it) in such a way as to bring the variations in pressure within such limits as he finds necessary or desirable, and to proportion the feeding conductors (if he knows how to do it) in such a way as to incur any drop in pressure along that he finds desirable.

Each claim of the patent is in terms for a single circuit, and the gist of each claim consists in combining such single circuit, feeding conductors for conveying electricity from the generator to the place where it is to be distributed, with a consumption circuit for distributing the electricity so conveyed to the various points to be so supplied.

Complainant's experts have made a strenuous attempt to show that there are certain broad limitations which sharply distinguish the circuit covered by these claims from anything which preceded it in the art. Prof. Chandler contends that central station regulation is an essential part of the system claimed. Sir William Thomson insists that central system regulation is an important, and, indeed, an essential part of the system he is discussing. They say that the circuit covered by the claims is a "comprehensive system" involving the use of "large numbers of incandescent lamps," with conductors extending "great distances" and covering "large areas," and involving the use of a "central station." But when asked to define these terms they are wholly unable to do so. The plant in the Dundee mill, referred to by Sir William Thomson as one of the best embodiments known to him of the feeder and main system, comprises 300 lights used for lighting a single building. When asked to define what he means by "a large number" of lights, the best definition he can give is: "I should think a good many hundreds—one hundred scattered over a considerable distance." All these vague limitations elude analysis, and will not bear examination. They are part of a studied attempt to lend fictitious dignity to this alleged invention, and to conceal its true character as a simple engineering expedient, by attributing to it the merit attaching to all the work that Mr. Edison and others have done in electric distribution, and to convey the impression that it is something large, complicated, and difficult of comprehension, requiring inventive genius of a high order to accomplish. Defendant does not (nor, apparently, does complainant), attribute importance to the limitation of the third claim, that the feeding conductors are to be connected to the centre of the main, as conferring patentability, although in the original application this was made the principal feature of the invention. The adjustment of relative size of the different parts of the circuit consists merely in making the feeding conductors of any size desired, and in making the consumption conductors sufficiently large to keep variations in pressure within such limits as may be desirable. The real issue, so far as patentability is concerned, is whether this circuit was new with Mr. Edison, or required invention in view of the prior state of the art. The *form* of the circuit was one which must necessarily exist in all cases where the lamps are at a considerable distance from the generator. Such cases frequently arise in practice, and it could hardly have involved invention to arrange the circuit in the only way it possibly could be arranged. No specific proportion of feeding conductors is called for by either of the claims, and in any event it could require no invention to use small enough conductors to incur any loss of pressure that for any reason might be desirable. The only remaining question is, whether it would require invention to make the distributing conductors large enough to distribute the current with proper equality of pressure, and this, by the admission of complainant's witnesses, is the only issue in the case, so far as patentability is concerned. Mr. Jenks, in his "New York Electrical Society" paper, says:—

"The feeder principle of distribution . . . . is entirely original with Mr. Edison, the methods of the gas companies, which were closely followed so far as they were adaptable to the government of the more potent agent which we utilised, did not at the time of the application for the feeder patents include any analogous means of equalising pressure."

This statement carries by necessary implication the conclusion that *if* the methods of the gas companies had included any analogous means of equalising pressure (as it has been shown that they did), Mr Edison would have adopted them if he had known of them, and Mr. Jenks would not have considered the feeder principle original with Mr. Edison. Mr. Edison himself, in numerous published statements, has insisted upon the analogy between his system and the gas and water systems. As a matter of fact, the methods of both the gas companies and the water companies did include strictly analogous and, in fact, identical means of equalising pressure, and this is true

to such an extent, especially of gas distribution, that the descriptions of prior gas systems in the testimony of defendant's witnesses, and in prior publications in evidence, would, by mere translation of the gas terms into the corresponding electrical terms, constitute a much better specification than that of the patent in suit, of the system of distribution covered by its claims.

It is conceded that the alleged invention of the patent in suit is applicable to the multiple arc system of distribution only, and has nothing to do with the series system; it is not, however, claimed that the multiple arc system of distribution was invented by Mr. Edison. Nor was he the first to discover that the resistance of a conductor carrying an electric current produces a drop in the pressure or tension of the current. The effect of changes in the size and length of the conductor, and of changes in the strength of the current traversing it, upon the fall of pressure, were well understood by electricians long prior to 1880, and formulæ had been worked out for calculating the proportions to be given to a conductor for securing a definite fall in pressure with a given current. It has been abundantly proven to have been a part of the common knowledge of the art, that for economically transmitting large volumes of electric energy to long distances, conductors should be used of considerably less size than would be required for maintaining an approximately equal pressure along the entire line of the conductor, and indeed this is admitted by Professor Chandler.

The claims in suit are anticipated by prior publications and uses relating to electroplating and electrotyping, in which the multiple arc system of distribution was employed. The necessity for equalisation of pressure in these applications is fully as great as in electric lighting, as has been recognised for many years. Long prior to the date of Edison's alleged invention, the method of equalising pressure described in his patent has been utilised, viz., making the distributing parts of the circuit of sufficiently thick conductors to avoid resistance, producing inadmissible differences in tension, and using conductors to transmit the circuit from the generator to the distributing conductors of any desirable size, without reference to the fall of pressure in them. The criticisms of complainant's experts as to the size of the apparatus, the length of the circuits, and the pressure of the current, are wholly immaterial to the question at issue, since it could manifestly involve no invention whatever to apply upon a large scale a principle which had been recognised and applied upon a small scale.

The British patent to Werdermann, and the Werdermann article in the *Telegraphic Journal* describes a peculiar form of multiple arc circuit, which has become known in the art as the "reversed parallel" circuit. So far as concerns the *form* of circuit of the patent in suit, it is shown in these publications, since no fall of pressure in the feeding circuit can affect the relative candle-power of the lamps connected with the other part. It is apparent that Werdermann's system was intended for distribution on a large scale and over considerable distances. The desirability of uniformity of candle-power is also recognised by him. Complainant's experts say that the vital difference between this system and that of the patent in suit is, that the former does not describe central station regulation. This is immaterial. The patent in suit does not describe central station regulation, and such regulation forms no part of its claims. Another criticism is that Werdermann describes an arc lamp, and proposes to use a current of low tension which would be unsuitable for wide distribution. This also seems quite immaterial. The gist of the invention of the patent in suit (if there is any invention) consists in the arrangement and proportioning of the circuit for securing uniformity of pressure, and this is not dependent on the kind of lamp or the tension of the lamp employed. Prof. Chandler's contention that it would require invention to use a lamp of higher resistance, and a current of higher tension for operating it in the Werdermann circuit, is of interest rather as showing to what shifts complainant's experts have been driven in an attempt to sustain a position legally untenable, than as requiring serious attention. Prof. Chandler thinks it would have required invention to use the Lane-Fox lamp in the Werdermann circuit, with a current of the tension specified by Lane-Fox for operating it. This, it is submitted, presupposes altogether too dense an ignorance, on the part of every one except Mr. Edison, of the commonest principles of electrical engineering.

There is no doubt that the French patent of Khotinsky describes the *form* of the circuit of the patent in suit. There is one part of the circuit, the two main conductors, to which all the lamps are connected, and there is another and distinct part of the circuit, the two wires connecting the magneto-electric machine to the main conductors, and to which no lamps are connected. It is specially to be noted that it described the connection of the feeders to the centre of the main conductors, specified in claim 3 of the patent in suit. The only real issue in regard to Khotinsky is narrowed down to the point whether, in using his form of circuit, under circumstances sure to arise in practice, it would require invention to make the main conductors of the lamp circuit large enough to be practically useful.

The Lane-Fox patents and publications are important, as showing an intelligent appreciation of the fact that fall of pressure was a difficulty which would be encountered in a multiple arc system of distribution on any extended scale; that the difficulty was due to the same causes of resistance to flow in the conduits, which produced the same difficulty in gas distribution, and that therefore it could be dealt with in the same way in electrical distribution as in gas distribution. As a general remedy, applicable as far as practicable, he adopted from gas distribution the proper proportioning of the distributing mains, making them large enough to avoid any harmful pressure. Then by reason of the extent of the system, it became impracticable to make the mains large enough to entirely obviate the difficulty; he therefore adopted one of the methods used in gas distribution, that of automatic pressure regulators. He does not describe the other method—equally well known in gas distribution—independent feeding mains with pressure regulators at the works; possibly because he was ignorant of it, but probably because he thought it was unnecessary. Lane-Fox's selection from gas methods turned out not to be a judicious one; the other one, that of independent mains, which Edison selected and described in the patent in suit, is better adapted to the requirements for electrical distribution, but both will accomplish the result, and both are borrowed bodily from gas distribution.

The Sawyer and Man patent of 1878 describes a multiple arc circuit, identical in form with fig. 2 of the patent in suit. The Sawyer and Man patent does not describe proportioning of the parts of the circuit, and hence the same considerations apply to this patent, in this regard, as to the Werdermann and Khotinsky patents.

That the elements of the combination of the patent in suit were all old, follows necessarily and as a legal consequence from the mere statement that they are elements of a combination, as has been shown by abundant authority. Moreover, the evidence shows, in fact, that the elements were old and well known in the prior state of the art. This proposition remains entirely undisputed, except as to a consumption circuit, properly proportioned, forming one of the elements of each claim. This is admitted by complainant's expert, Sir William Thomson, to be old, or at all events to be such a construction as would naturally have suggested itself to a person skilled in the art; complainant's other expert, Prof. Chandler, made the same admission on cross-examination, and his subsequent attempt to take a different position is a flat contradiction of his previous testimony, and is in any event wholly illogical. Such a consumption circuit was, in fact, described in the prior patent of Lane-Fox; was well known in electroplating, and would not in any event have involved any invention, but only the exercise of mere mechanical skill and judgment, in view of its well-known application in the strictly analogous arts of gas and water distribution, and the common recognition among electricians of the strict analogy between multiple arc electric distribution and gas and water distribution. Furthermore, the proportioning of the consumption mains in the claims in suit was not described at all in the original application for the patent, and if it was not well known in the art, then the patent is for a different invention from that described in the original application, and therefore void. This is the logical result of the position Prof. Chandler endeavours to take in regard to the Lane-Fox patent. There is no escape from this dilemma: Either the claims of the patent cover an invention not described in the original specification, or the fourth element of the alleged combination, viz., a properly proportioned consumption or service circuit, was not in itself new at the date of the application, or of Edison's alleged invention, but had been described in the Lane-Fox patents and publications, or was otherwise known to persons skilled in the art.

It is further contended by defendant that there is no patentable novelty in the combination claimed. It is established by the evidence of complainant's own experts, that the combination covered by the claims of the patent in suit did not involve the exercise of invention, but merely of engineering or mechanical skill, in view of the state of if the art at and prior to the date of Edison's alleged invention. The gist of the alleged invention consists in nothing more than the use of transmitting conductors, of any size that may be desirable, for construction or otherwise, to transmit the current from the generator to the place where it is to be distributed, and distributing conductors made large enough to distribute the current without causing by their resistance inadmissible differences of pressure. Complainant's experts admit that the use of such transmitting conductors was well known in the art, and that it would not have involved invention but the merest engineering skill to use such transmitting conductors for supplying current at a distance for any purpose whatever. The only question left, therefore, is whether it would have involved invention to make the distributing conductors large enough under such circumstances. Sir William Thomson admits that such construction would have naturally suggested itself to a constructor at that time. Prof. Chandler admitted the same thing on cross-examination, but retracted it on redirect. As a matter of fact, the proofs show that such construction of the distributing conductors was described by Lane-Fox in his patent of 1878, and had been used largely in electroplating. The prior patents of Werdermann and Khotinsky undoubtedly described the *form* of circuit covered by the claims in suit, and the *proportioning* of the circuit in the manner set forth in the patent was a matter not requiring invention, but only the exercise of the merest engineering and mechanical skill and judgment at the date of Edison's alleged invention. If these claims are valid they preclude the public from using the forms of circuits described by Werdermann and Khotinsky, in cases frequently arising in practice, such as the lighting of a building from a generator some little distance away, in the manner which would necessarily be adopted by any engineer, unless he ignored the commonest expedients known in the art at that date.

The prior publications and uses relating to gas and water distribution constitute a complete anticipation of the claims of the patent in suit. All the points of difference between gas systems and electrical systems, insisted upon by complainant's experts are mere differences in detail, not in any way affecting the general principles on which the claims depend, and the general principles contained in both cases, especially so far as relates to the specific matters dealt with by the patent, are identical.

The system of distribution covered by the claims in suit is not a legitimate combination within the meaning of the patent law, but a mere aggregation, and therefore no patentable subject matter. Two distinct functions are involved in the systems of circuits described in the patent: Transmission of the electricity from its source to the locality where it is to be utilised, and distribution of the electricity among the devices there to be supplied. The system is therefore one of transmission *and* distribution; not one of distribution alone. The function of transmission is performed solely by the feeding circuit; that of distribution solely by the transmitting circuit. Each part of the circuit works after its kind, without reference to what occurs in the other part. This independence of function is recognised and

even emphasised in the specification. There is no co-ordination of functions, and no unitary result, but a mere aggregation of functions and aggregation of results. This is not a mere technical point of law, but goes to the merits of the case. It is another way of stating that the various elements of the alleged combination are used to perform their recognised functions; with such results as would naturally be expected, because they were the ordinary results of the action of the parts. Such an aggregation is not patentable. It was doubtless to avoid this conclusion that complainant made such strenuous efforts to inject central station regulation into the patent, as an essential element of the combination, to furnish some connecting link giving apparent co-ordinate action to the parts, but the patent furnishes no warrant for this, and in any event it would not materially affect the question.

To create a further presumption of patentability complainant has tried to prove that the alleged invention supplied a long felt want, and was immediately recognised as a very important contribution to the art, but all the testimony of complainant's witnesses on this point is a studied attempt to confuse the *specific* problem of equalisation of pressure, with which the patent purports to deal, with the *general* problem of producing a comprehensive system, capable of supplying the electric light for general illumination. It is a fact that this general problem was a very difficult one, and was universally so considered, but it is not true that the specific problem of the patent in suit was regarded by anyone prior to Edison's alleged invention, except, perhaps, by himself and his associates, as involving any invention whatever. The testimony of complainant's witnesses is, that no experiment was required for making the alleged invention, but, on the contrary, Edison proceeded, without making any experiments whatever, to embody the system of circuits in a large and extremely costly plant in New York City. This would indicate that, so far as he was concerned, the applicability of the scheme to an incandescent lighting system was quite obvious, without experiment, as soon as the occasion arose for using it.

The history of the application of the patent in suit, as revealed by the proceedings in the Patent Office, shows that an amendment of a radical nature was made more than two years after the application was filed; made by the attorney without any oath from Mr. Edison or any one else; that the element containing the very gist of the claim, viz., a properly proportioned consumption circuit, was not described at all in the original specification, but appeared for the first time in an amendment filed by Mr. Edison's attorney. In the original application the principal features of the invention were: 1. Having no lamps on the feeding conductors; 2. Feeding conductors to tap the lamps of these conductors at their centres; 3. Lamp circuit conductors to taper from the centre to the ends; 4. Lamps placed on circuits derived from lamp centres only. By eliminating the central connection of the feeders, not only was the scope of the invention materially broadened, but the very corner-stone of the invention, so far as concerns equalisation of pressure in the lamp circuit, was removed bodily. The tapering of the lamp-circuit conductors, an essential part of the original statement of the invention, was also eliminated in the amended specification. The changes in the specification were necessarily radical, because the claims in suit could not have been supported by anything found in the original specification. Mr. Brevoort undertakes to say that "the file-wrapper all through describes and explains the invention set forth in the first three claims in the patent." Complainant's case on this point is perhaps not helped by this opinion under oath on a question of law, and it may be remarked in passing, that the particular expert selected for this purpose is one who has had no practical experience in electric lighting and who is least acquainted of all complainant's experts with the art. On his own showing he has made no examination of the literature of the subject and has no familarity with it, and hence has no special competence to instruct the court even upon the technical points involved. None of the other experts have undertaken to verify this proposition of law. The amendment in fact constituted a description of a new invention, not described at all in the original application, which is made a constituent and essential ingredient in each of the claims in suit. There is therefore, a fatal variance between the present claims and the original application, and the claims are for that reason void.

Furthermore, prior to the filing of the real application of the patent in suit, viz., the amendment filed August, 1882, Edison took out another patent in which the invention now claimed is described but not claimed. By this description in a prior patent, the patentee and his assignee of both patents, the complainant, is estopped in asserting any novelty for it in this patent, hence the claims in this patent are void for this reason also.

The evidence on the issue of infringement is very conflicting. The complainant has not only failed to sustain the burden of proof, but the preponderance of evidence shows a construction of the circuits of defendant's plant which would not, upon any admissible interpretation of the claims be covered by them.

It is respectfully submitted that the bill should be dismissed with costs.

NEW PATENTS—1892.

12,691. "Improvements in electro-magnetic apparatus for controlling electric light and power circuits." S. F. WALKER. Dated July 11th.

12,700. "A new or improved apparatus for carrying or conveying telegraph or telephone wires over houses or buildings." D. W. PEAKS. Dated July 11th.

12,719. "Process of making aluminium." H. J. ALLISON. (Communicated by P. A. Emanuel, United States.) Dated July 11th.

12,731. "Improvements in electrolytic extraction of zinc." SIEMENS BROTHERS & COMPANY, LIMITED. (Communicated by Messrs. Siemens & Halske, Germany.) Dated July 11th.

12,735. "Improvements in supports for telegraph insulators." J. C. FULLER and G. FULLER. Dated July 11th.

12,737. "Improvements in electrical switches and incandescent lamp holders." T. JENNER and G. B. WILKES. Dated July 11th.

12,745. "Electric signalling apparatus." H. J. ALLISON. (Communicated by the Standard Electric Signal Company, United States.) Dated July 12th. (*Complete.*)

12,759. "Improvements in or relating to electric railways, especially those in which underground conduits are used, and in rolling stock for the same." W. P. THOMPSON. (Communicated by A. H. Hieatzman and H. D. Hieatzman, United States.) Dated July 12th.

12,807. "Improvements in apparatus for regulating the arc in electric arc lamps." A. W. MONEY and H. NASH. Dated July 12th.

12,818. "Improvements in conduits for electric railways." J. E. EVANS-JACKSON. (Communicated by C. D. C. Huestis, United States.) Dated July 12th. (*Complete.*)

12,888. "Improvements in electrical regulating devices for clocks." L. VON ORTH and E. BRESLAUER. Dated July 13th. (*Complete.*)

12,906. "Improvements in and relating to 'roses' or electrical connections for the ceilings of buildings or structures." W. M. HADDOW and J. S. HUTCHISON. Dated July 14th.

12,977. "Improvements in the electrolytic production of caustic soda or caustic potash." C. A. BURGHARDT. Dated July 15th.

12,999. "Improvements in the method of and means for distributing electric currents." G. KAPP. Dated July 15th.

13,072. "Improvements in coupling and fixing glass tubes for containing electric wires." D. RYLANDS and S. SLATER. Dated July 16th.

13,090. "Improvements in portable electric lamps and safety fuses for same." K. W. HEDGES. Dated July 16th.

13,095. "Improvements relating to the electric heating of pottery and other furnaces and materials therefor." F. VON POSCHINGER. Dated July 16th.

13,105. "Improvements in attaching drums to telegraph poles.' H. C. JOBSON. Dated July 16th.

13,134. "An improved form of voltmeter." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated July 18th.

13,143. "Improvements in the manufacture of India-rubber for insulating and other purposes." C. RAWLE and H. MCKENNA. Dated July 18th.

13,146. "Improvements in microphones." Sir C. S. FORBES. Dated July 18th.

13,160. "Increasing the efficiency of telephonic communication and transmitting speech." T. ODDY. Dated July 19th.

13,167. "Electric arc lamp." W. E. IRISH. Dated July 19th. (*Complete.*)

13,202. "Improvements in gramophone reproducing apparatus, or mechanism for reproducing sound vibrations recorded by the gramophone." A. FLURSCHEIM. Dated July 19th.

13,207. "Improvements in incandescent electric lamps." L. STIRN. Dated July 19th.

13,218. "A process for covering or insulating submarine cables and underground installations, and other purposes." T. S. LEMON. Dated July 19th.

13,221. "Improvements in or connected with telephones." W. DECKERT. Dated July 19th. (*Complete.*)

13,288. "Improvements in connections for electroliers and other electric light fittings." H. HIRST. Dated July 20th.

13,297. "Improvements in electropathic appliances for human wear." W. W. HORN. (Communicated by R. S. Mears and W. C. Powers, United States.) Dated July 20th.

13,323. "Improvements in or connected with the production of electric energy." H. C. BULL and G. B. COWL. Dated July 21st.

13,335. "Improved means for signalling by electricity on railways." T. WHITTINGHAM. Dated July 21st.

13,337. "Improvements in electric belts, which improvements are also applicable to other purposes." G. W. HAUNAM. Dated July 21st.

13,338. "An improved switchboard." SIR C. S. FORBES. Dated July 21st.

13,358. "Improvements in or relating to alternate current circuits." W. M. MORDEY. Dated July 21st.

13,375. "Improvements in or relating to electric meters, recording apparatus, and controlling gear." W. L. SPENCE. Dated July 21st.

13,380. "Improved means of preventing injury to telegraph cables connected with lightships and floating stations." F. Le B. BEDWELL. Dated July 21st.

13,381. "Improvements in the manufacture of electrical storage plates, cells, or accumulators, and the accessories thereto." E. B. BRIGHT and L. W. MERCIER. Dated July 22nd.

13,389. "Improvements in voltmeters." F. BROWN. Dated July 22nd.

13,395. "Improvements in or relating to electrical apparatus for signalling." M. MERCIER. Dated July 22nd.

13,405. "Improvements in portable Leclanché batteries." H. NEHMER. Dated July 22nd.

13,453. "Improvements in electrodes for use in electrolytic apparatus, and in their manufacture." G. BAMBERG. Dated July 23rd.

13,473. "Improvements in apparatus for heating purposes, and cooking by means of electricity." G. BINSWANGER. Dated July 23rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

17,107. "Improvements in electric arc lamps." J. H. RIDER. Dated October 8th. Claim:—In electric arc lamps the use of two or more pairs of carbons in the one lamp, the said pairs of carbons being connected in series with each other, and arranged to burn at the same time, substantially as described.

17,734. "Improvements in electric switches." O. LINDERS. Dated October 16th. Consists in combining with a reversing switch a circuit breaker, by which the said switch is manipulated, the said circuit breaker being so connected to the switch, that on actuating the said switch, the current is interrupted by the circuit breaker, before contact has been made between the contact pieces of the switch. 1 claim.

17,971. "Improvements in electric clock winders." J. W. DULANEY and C. F. DULANEY. Dated October 20th. Relates to devices for automatically winding up clocks by means of electricity. 3 claims.

1892.

1,318. "Improved means or arrangements for electric distribution." A. W. CUTLER. Dated January 24th. Has reference to the arrangement and use in connection with continuous electric current transformers or motor generators, of means for automatically connecting the transformers (or transformer) to the desired electric circuits at the proper moment, so that transformers can be used and controlled at a distance from a generating centre or station. 4 claims.

3,373. "Improvements in and connected with medical batteries." G. F. WEBB and J. A. CRISP. Dated February 24. The object of the invention is to produce a battery, and attachments therefor, which may be conveniently carried upon the body and by means of which a constant galvanic current may be sent through any part of the body, and also to produce electrodes which may contact with the body without corroding and without cutting or injuring the body in any way. 9 claims.

3,398. "An improved electrical burglar alarm." A. E. SPENCER. Dated February 25th. By means of a cord or other suitable arrangement a wedge is fastened to the blind, when the latter is pulled down. The blind thus directly connected with the alarm will, when touched, pull out the wedge immediately, whereby a clip will close, thus making contact, and the bell or gong will be started. 2 claims.

3,664. "Improvements in electrical switches." G. BINSWANGER. Dated February 28th. The inventor employs a link connected with and joining together the contact bar and the rocking handle, in such a manner that when the handle is moved over to release the contact bar, and its motion being continued far enough, the link serves to communicate this motion to the contact bar, and pulls it out of contact, and so either materially aiding the action of the spring or superseding it altogether. 2 claims.

REVIEWS.

Induction Coils: A Practical Manual for Amateur Coil-Makers. By C. E. BONNEY. London: Whittaker and Co., Paternoster Square.

The manufacture of an induction coil has always been a favourite pastime for amateur electricians, and although the instrument when complete is not one with which very numerous experiments can be made, yet there are so many useful practical hints which may be gained in the course of the construction of the apparatus, that the manufacture is a valuable experience of how to overcome difficulties. In Mr. Bonney's useful book every part of the coil is described minutely in detail, and the methods and materials required in insulating and winding the wire are fully considered. We notice that the advantage of the system of winding coils with a central division is only incidentally referred to; this arrangement besides equalising the electric strains in the coil has the great merit of getting rid of that most objectionable feature in coils, namely an "inside end," which is always liable to be broken off accidentally, and when this occurs it means unwinding the whole coil to get at and repair the same.

With reference to the chapter on "Some Famous Coils," we may mention that an interesting description of a very large induction coil constructed by Dr. Callan, of Maynooth, with a secondary of "iron" wire, was given in a number of *The Electrician* (the forerunner of our contemporary) of about the year 1863; the length of the secondary in this coil was 30 miles, and the length of spark given was 17 inches. It was stated that Dr. Callan found that iron was superior to copper for the secondary coil; whether this is actually the case seems doubtful, but at the same time it rather goes against the statement, which is often made, that copper of the highest possible conductivity is very necessary.

Telephones: their Construction and Fitting. By F. C. ALLSOP. Second edition. E. & F. N. Spon, 125, Strand, London.

A considerable enlargement has been made in this work, several large folding plate diagrams having been added. The book as it now stands is a very complete practical treatise, though, of course, it does not contain all that could be said on the subject.

Journal of the Institution of Electrical Engineers, No. 99. London: E. & F. N. Spon, 125, Strand.

The chief contents of this No. are as follows:—"Notes on the Light of the Electric Arc," by A. P. Trotter; "On the Cause of the Changes of Electromotive Force in Secondary Batteries," by J. H. Gladstone and W. Hibbert.

Notes on the Construction of Cranes and Lifting Machinery. By E. C. R. MARKS. London: John Heywood, 2, Amen Corner.

The literature on this subject is but scanty, and although perhaps there may not be any very great demand for a book of the kind, yet there must be several to whom the information given will be of great service. The notes were originally written in the form of a series of articles for *The Practical Engineer*. The book is divided into twenty-two chapters, as follows:—I, Pulley blocks; II., Crabs and winches; III., Double-purchase crabs; IV., Treble-purchase crabs; V., Hand cranes; VI., Pillar cranes; VII., Ship cranes; VIII., Foundry cranes; IX., Derrick cranes; X., Wharf cranes; XI., Portable cranes; XII., Overhead travelling cranes; XIII., Steam power hoists; XIV., Power cranes for warehouses; XV., Cage or car lifts; XVI., Locomotive steam cranes; XVII., Fixed steam cranes; XVIII., Steam power overhead travelling cranes; XIX., Rope-driven travelling cranes; XX., Lifting jacks; XXI., Chains and ropes. It will thus be seen that a large amount of ground is covered, though no mention is made of hydraulic apparatus. Useful details are given of various parts, and dimensions are figured on the illustrations, which is a great advantage. Altogether the work may be considered as a serviceable and useful addition to the engineering library.

CORRESPONDENCE.

Concentric Wiring.

In the article you publish in your issue of 29th ult., headed Mavor and Coulson's Patent Junction for Concentric Wiring, you correctly state that the difficulty of making junctions in concentric wiring has now been overcome by a method of hermetically sealing with molten metal. The origin of this method of jointing, however, lies with myself, and I hold the patent right, a copy of the specification of which I beg to send you. In view of the wide field that is open for this method of wiring, my firm are giving liberal terms to trade firms for the use of our patent rights, either by license to manufacture or by selling the materials, and giving free instruction in the details of the system. I may add that the form of joint we are now using is a great improvement, especially in the direction of simplicity and cheapness, on the one we originally introduced, a modification of which is described in your article.

The favour of your inserting this letter, with the marked extracts of the specification, will greatly oblige.

J. D. F. Andrews.

August 1st, 1892.

EXTRACTS FROM SPECIFICATION.

Instead of applying the fusible metal, so as to occupy the whole space between the sleeve and the internal insulating material, it may be applied to occupy only dovetail recesses formed in the sleeve, the rest of the interior of the sleeve being filled with insulating material. When the sleeve has to be put on in halves, as in the case of a T junction, the metal, when it solidifies within the dovetail recesses of the sleeve, serves to hold the halves of the sleeves together, as well as to make metallic connection with the armour.

The inventor claims:—The modified joint, wherein the fusible metal is poured into dovetail recesses at the ends of the sleeve.